VOLUME 81 NUMBER 12

POWER

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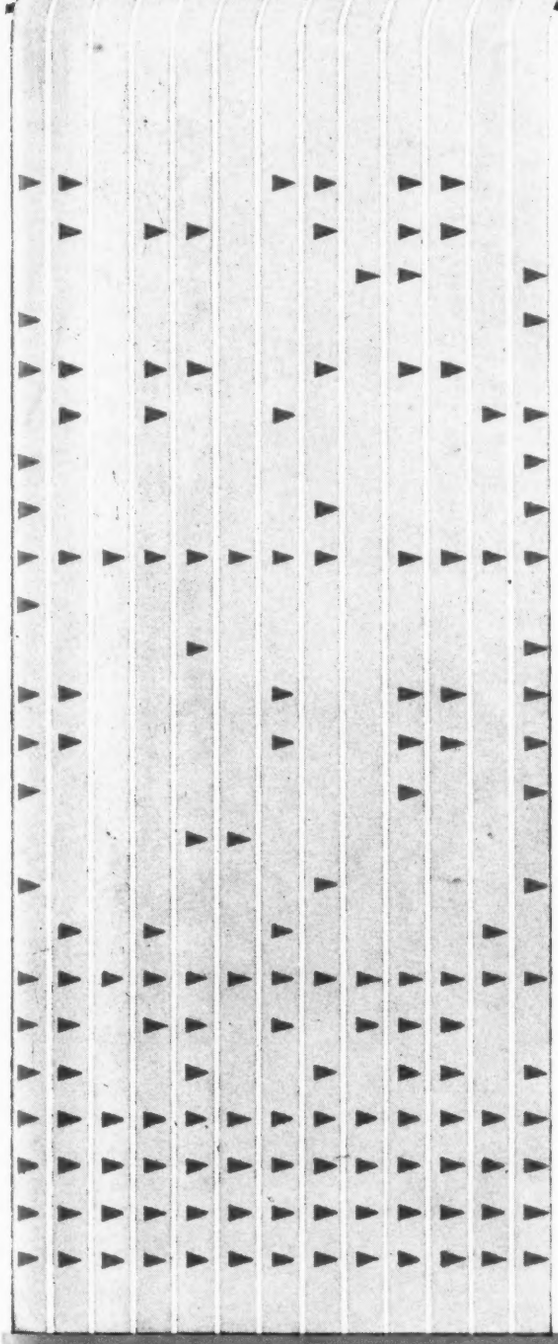

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McGRAW-HILL PUBLISHING COMPANY, INC.
Publication office: 99-129 North Broadway, Albany, N. Y.
Editorial & Executive Offices: 330 West 42nd St., New York, N. Y.

JAMES H. MCGRAW, JR., President · HOWARD EHRLICH, Executive Vice-President · JAMES H. MCGRAW, Honorary Chairman
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CHICAGO, 520 North Michigan Ave. · SAN FRANCISCO, 883 Mission St. · WASHINGTON, National Press Bldg. · PHILADELPHIA, 16 South Broad St. · CLEVELAND, 1510 Hanna Bldg. · DETROIT, 2-257 General Motors Bldg. · ST. LOUIS, 455 Paul Brown Bldg. · BOSTON, 1427 Statler Bldg. · ATLANTA, 1105 Rhodes Haverty Bldg. · LONDON, Aldwych House, Aldwych, London, W.C.2

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POWER articles are currently indexed in both the Industrial Arts and the Engineering Indexes, available at public libraries. Also every year POWER issues an annual index of its own. Cable Address: "McGraw-Hill, N. Y."

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●The trend in industry is toward lower operating and maintenance expenses. Greater attention is focused on low ultimate cost of equipment rather than lowest first cost. The insistence for durable piping materials is reflected in the new Beef House specification of Armour & Company, Chicago. Here Byers Wrought Iron pipe was installed in the all-welded system for cold water, hot water (210° and 90°) and steam return lines.

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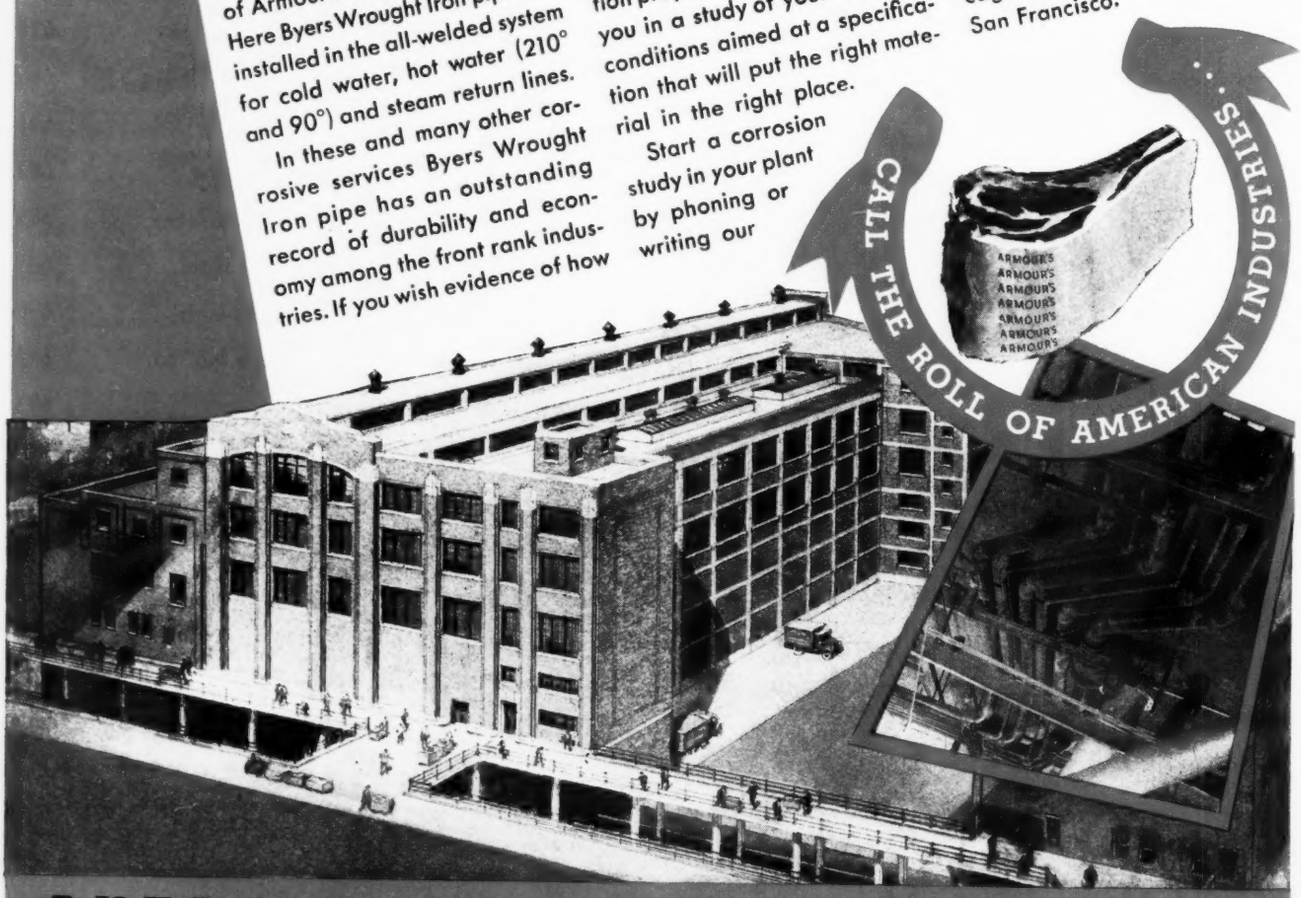

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POWER

ESTABLISHED 1882

20 Per Cent More Opportunity...

» UNLESS ALL SIGNS fail, we face many years of rising fuel prices. This forecast is advance notice of a money-making opportunity for the individual industrial coal user, rather than a warning of future trouble.

First, coal: The Guffey-Vincent Bituminous Coal Act of 1937 is now in operation. From now on it will be unlawful to sell coal below cost. A commission will fix minimum FOB mine prices for each locality and each classification of coal. The minimum so set cannot be less than the average cost of production for the region.

The Guffey-Vincent Act is a vigorous attempt to rescue the coal industry from its chronic state of low wages and profitless business by limiting the operation of free competition. This limitation is now a fact, whether we like it or not. Higher prices will surely result.

Will not the Act eventually break down under the weight of its own red tape? The Act will develop many operating flaws requiring extensive amendment, or even a new law some years hence. But coal experts say that its essence—control of competition—is here to stay. Therefore, FOB mine prices should go up and stay up, particularly in the case of steam coal, which in the past has borne the brunt of ruinous cost cutting.

Then comes the matter of freight, which generally costs even more than the coal FOB mine. At this very moment the railroads are actively petitioning for a rate increase. With increased railroad labor and equipment costs, higher freight rates in years to come seem certain. The conclusion is that coal at the user's plant must cost substantially more.

How about fuel oil, specifically boiler oil? Here again every indication points to higher prices. Tax burdens on petroleum production, pipeline transportation and refinery operation grow at an alarming rate with no prospect of reduction for many years. Cost of delivery by rail or ship will increase.

The bottom of petroleum resources is not yet in sight, but new production will come more and more from deep drilling and hence will be more costly. Once boiler oil was a by-product, to be dumped at any price which could compete with coal. Household fuel oil will absorb a larger proportion of the petroleum, leaving less of the heavy residuals for industrial use.

Granted that fuel prices will be higher in the future, and assuming (for the sake of discussion) a 20% rise, what will this mean in terms of burden and opportunity?

The burden angle *seems* obvious. 20% more must be paid for each ton of coal and each gallon of oil. Yet this should not appreciably hamper the business of fuel consumers. It will be a burden laid equally upon all and therefore one that can be passed along to the buyer of the manufactured product. Competitively, each plant will stand as before, *except*.

In the exception lies the competitive opportunity. Today, and always, the plant that burns fuel more efficiently, and eliminates waste in steam use, has an advantage over its less-efficient competitor. If fuel prices rise 20%, that advantage is increased 20%.

Thus, 20% higher fuel prices mean 20% more opportunity. But this future opportunity requires action now, not merely in the future. The die is cast when a plant is built or modernized; present construction sets a top limit to future efficiency.

Power urges its readers to consider the future in their present construction and modernization plans—to remember that there will probably be 20% more to be saved by designing fuel economy into their plants and that this justifies a greater capital investment today.

PHILIP W SWAIN
EDITOR

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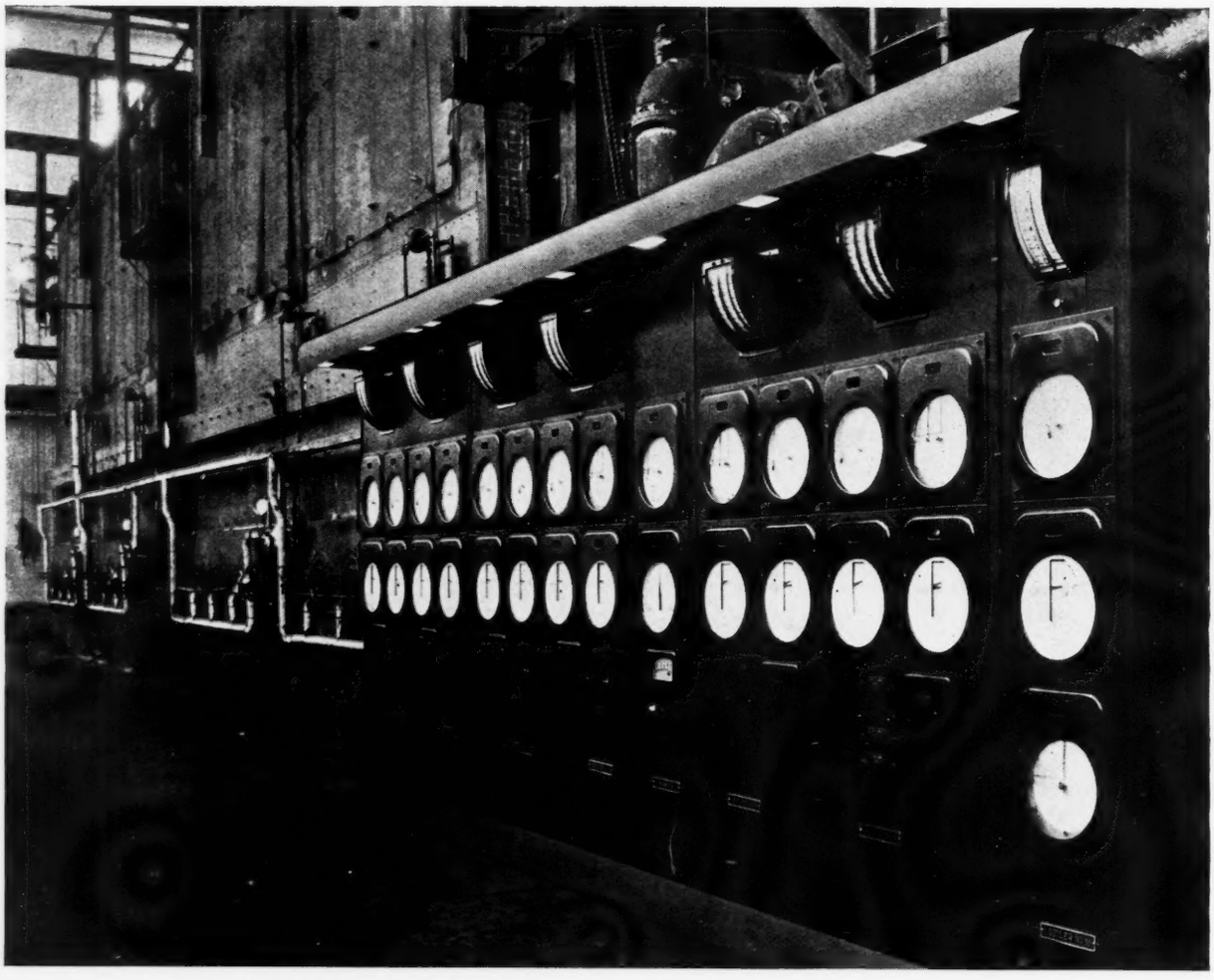


Fig. 1 — On this automatic-combustion-control and meter board is essential equipment for operating the boiler plant under practical test condition at all times

Modernization a Habit
With Bigelow-Sanford

Better operation, modernization, combining heating and power loads, power-factor correction and adequate metering intelligently used feature a program that cut fuel 25% and produced other large savings

WHEN STEAM-ELECTRIC power and heating loads can be served jointly, power practically becomes a byproduct of the heating steam, and cost is reduced accordingly. By a progressive modernization program, this is the end toward which the Bigelow-Sanford Carpet Co, Inc, has been working for several years. The methods which this company has used to adjust its power- and steam-generating equipment and heating requirements to meet its manufacturing demands most economically points the way for many other manufacturing-plant engineers to reduce operating costs.

This company is one of the largest manufacturers of high-grade carpet and rugs in the world. Its plant at Thompsonville, Conn, contains a floor area of 44 acres and employs 3,200 to 3,500 people. To operate the plant in 1936 required 11,500,000 kwhr and 800,000,000 lb of steam per year and 2,000,000 to 3,000,000 gal. of treated and filtered water per day. About 20% of the water must be heated.

Originally, steam for process-water heating, washing, dyeing, drying, and for heating the mill, was supplied at 150 lb g and 100 F superheat, power being provided by two 750-kw, 600-volt, 40-cycle, 3-phase generators, driven by cross-compound, condensing engines operating on steam of the same quality. Changes have been made so that a large part of process heating is done now with 2- and 15-lb steam from the power-generating units. All hot water for the mill is heated with 2-lb exhaust steam, this water being supplied at about 150 F, as hot as it can be used in process. A large part of secondary heating of water in process, drying and 88% of building heating, is done with 12- to 15-lb steam bled from power-generating units. During this progressive modernization program, productive capacity has been increased and power-plant efficiency materially bettered. The plan followed in making the improvements was: first to make the best use of the equipment available, then gradually change the old setup and add new equipment when engineering studies and load requirements showed that changes were justified.

The present power plant comprises one 3,250-sq ft, four 6,910-sq ft and two 7,240-sq ft oil-fired boilers. With the exception of the small one, all are comparatively new and in regular daily service. The small unit is older and is used over weekends and for standby. The two largest boilers have economizers and radiant superheaters where the other four have convection superheaters only. The large boilers are designed for 200 lb and 100 to 150 F superheat, and have been operating at 165 lb g.

Power Units

Power-generating equipment includes two 750-kw alternators driven by cross-compound steam engines, a 150-kw non-condensing geared turbine-generator, a 1,000-kw mixed-pressure condensing turbine-generator, a 2,500-kw bleeder condensing turbine-generator, an 1,875-kw backpressure turbine-generator, and a 75-kw engine-driven dc generator. The latter, originally the exciter for the engine-driven generators, is used now for standby, and the 150-kw turbine unit operates to supply weekend lighting and similar services. Practically all boiler and power-plant auxiliaries are steam driven, exhaust from them being used for heating boiler-feed and process water.

For the purpose of this account we will start about 15 years ago. Power-generating equipment included only the two engine-driven generators with the engine-driven exciter and the mixed-pressure turbine. During week-ends and other periods when the mill was shut down, load was so light that any one of the generating units operated at very low efficiency. This was corrected by installing the 150-kw turbine-generator with a direct-connected exciter. This unit is still used for that purpose.

At that time all building and process heating, including mill water, was done by high-pressure steam, the steam engines and the turbine operating condensing. In 1926, heater tanks were installed in the power plant for heating the process water with exhaust from the engines and powerhouse auxiliaries, any excess exhaust going to the mixed-pressure turbine. Part of the heat in the exhaust previously lost in condensing water was now utilized for heating process water. Exhaust used in water heating replaced nearly an equal amount of live steam previously used.

Building and other process heating was still done with live steam, and because of the oil in the engine exhaust going to the turbine, condensate was discharged to the river. Power load continued to increase, making more generating capacity necessary, and this provided the hook on which to hang the next economical move. The boiler plant was brought to its present capacity and a 2,500-kw turbine-generator was installed to operate condensing and arranged to bleed at 12 to 15 lb. Changes were also made in the process to permit the use of 12-lb steam for heating and dyeing, thus again reducing demand for high-pressure steam for these purposes. Bleeding low-pressure steam from the turbine for heating improved the thermal efficiency of the power plant, as heat formerly thrown away in the condensing water now serves useful purposes.

Water Heating

From 2 to 3 million gallons of water per day are required for process, about 20% of which must be heated. To utilize as much as possible of the heat in the steam from the large turbine, it was equipped with a 2-section condenser. Baffles in the water boxes permit passing process water through the tubes in the top quarter of the condenser, where its temperature is increased before going into the heating tanks. Circulating water from the river is passed through the bottom three-quarters of the condenser (see Fig. 2).

In 1935, power load, which comprises about 1,300 motors in fractional- to 50-hp sizes, began to approach the capacity of the cable system. A study of the problem showed that the installation of 2,000 kva of capacitors on the load ends of feeders supplying the low power-factor load was the most economical solution to the problem. Sufficient capacity was installed to correct power factor from 72 to 90%.

Improved PF

Installation of the capacitors brought load within the capacity of the cables, reduced power losses in the feeders about 50%, and improved voltage regulation, which has resulted in higher and more constant machine-motor speeds, thus increasing and improving production. In the power plant, improved power factor has reduced the load until the plant can be operated with one less unit on the system, and other prime movers are more efficiently loaded. One year's saving, from the improved efficiency in the power plant alone, approximates the cost of the capacitor installation.

To provide more boiler capacity, it was decided to go to oil firing. Several factors influenced this decision: Increased boiler capacity was required and could be obtained from the present units by a change to oil; the time was approaching when it would be necessary to replace the stokers; banking losses could be reduced to a minimum with oil firing; and ash-handling facilities were inadequate and would soon require remodeling. In addition, the price differential in favor of oil compared to coal was sufficient to make

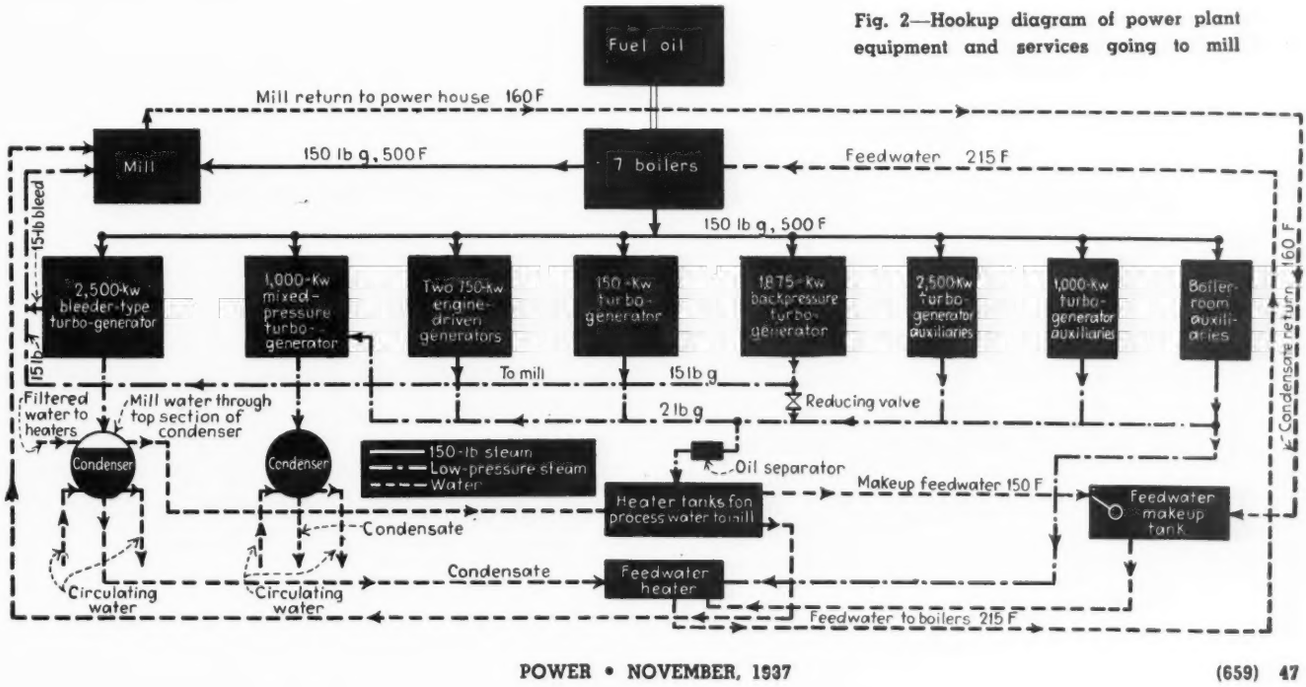


Fig. 2—Hookup diagram of power plant equipment and services going to mill

the change to oil burning economical. This work was completed in 1936. The change to oil firing has been made with pulverized coal in mind should fuel prices make a change to it economical.

Fuel oil is received in tank cars and is stored in eleven 30,000-gal. steel tanks, installed underground and insulated with about 18 in. of sand. They are piped to two headers so that by opening valves, oil may be discharged by gravity from the cars to any one or more tanks. Similarly oil may be pumped to the burners from one or more tanks at one time, Fig. 3. Each tank is equipped with a temperature recorder and level indicator. A heating coil around the pump suction and one in the bottom of each tank maintains oil temperature at about 100 F in tanks being pumped. This temperature is about as high as can be used without giving trouble with vapors in the suction pipe.

For a time after the oil-burning equipment was started, oil was pumped to the burners from one tank only. Because of the large amount of oil used (up to 36,000 gal. per day), it was found that operation could be simplified by pumping two tanks simultaneously. Operating conditions automatically cause the tanks to draw down together. If one tank tends to empty faster than the other, the lower liquid level will increase the suction head and the pump will draw less oil from it. Also, if more oil is being drawn from one tank than the other, the lower temperature of the larger amount will tend to decrease and slow down the flow. These factors seem to have considerable influence, for at one time the oil level of one tank may be lower than the other, but the oil gradually comes to the same level in the two.

Automatic Control

When the change was made to oil firing, all seven boilers were equipped with complete automatic combustion control. This comprised a master panel and a control and meter panel for each boiler. The master panel includes a master regulator receiving its impulses from steam pressure, and through the fuel and air regulators on the boiler panels adjusts the combustion process according to steam demand. On the master panel are also a draft gage connected to the forced-draft duct, into which all forced-draft fans discharge; and a recording steam-flow meter.

Boiler Control

On each of the six large boilers the control comprises a fuel-flow regulator, a combination air-flow regulator and boiler-load indicator, a furnace-draft regulator, a steam-flow and integrator, a combination CO_2 and 2-point temperature recorder, the latter recording the gas temperature at inlet and outlet of the economizer, and a 3-point draft gage connected to the windbox, furnace and uptake. Pushbuttons are also provided on each panel so that each boiler may be switched onto automatic or manual control, or taken out of service. When on manual control, all functions of operation can be controlled from the panel by pushbutton.

On these panels are centered all control and metering devices for operating the boilers under practical test conditions. In addition to the control panel meters, venturi meters are installed in the feedwater lines and a flowmeter in the fuel line to each furnace. Consideration is being given to install eye-level water-level gages so that the operator may easily see water level on all boilers without leaving the meter and control panels.

A large part of all heating equipment still operating on high-pressure steam was put onto the 15-lb system this year. This increased the demand for 15-lb steam beyond that which could be supplied by the 2,500-kw turbine. Power load had also increased to where additional generating capacity was required. The two demands have been met by installing an 1,875-kw turbine-generator exhausting at 15-lb backpressure. This unit increased power-plant capacity to 6,875 kw to supply a maximum load of about 4,000 kw at 90% power factor. Normally all load is supplied by the two large turbine units, the engines and mixed-pressure turbine serving as standby. The engines are old and uneconomical to operate except on standby service and will gradually be replaced when the load increases to a point at which more firm capacity is required.

A new feedwater heater was also installed this year. This heater has a capacity of 350,000 lb per hr, heated from 100 to 215 F and is on a steel structure above the old one, arranged so that either or both may be used.

In the near future, to improve thermal efficiency, it is planned to increase boiler pressure to give 180 lb at the turbine throttles. This year, the 2,500-kw machine was overhauled and changed to operate at this pressure efficiently. The two large turbine-generators have been installed with a change from 40 to 60 cycles in mind. Should this become economically desirable, these units are so designed that they can be readily adapted to this service.

In spite of all changes in the plant, an orderly arrangement of equipment has been maintained. In fact, not many new plants are any more convenient to operate, or have a more pleasing appearance.

Meters

The power plant is equipped with meters and automatic control so that it operates practically under test conditions at all times. A comprehensive log is maintained, and from these records, plant performance is under daily check. In spite of the fact that the boilers are of conventional design in refractory settings, have only two economizers, and serve a widely fluctuating load with long night and week-end shutdowns, an average monthly boiler and furnace efficiency is maintained around 78%.

Power, steam and water are metered

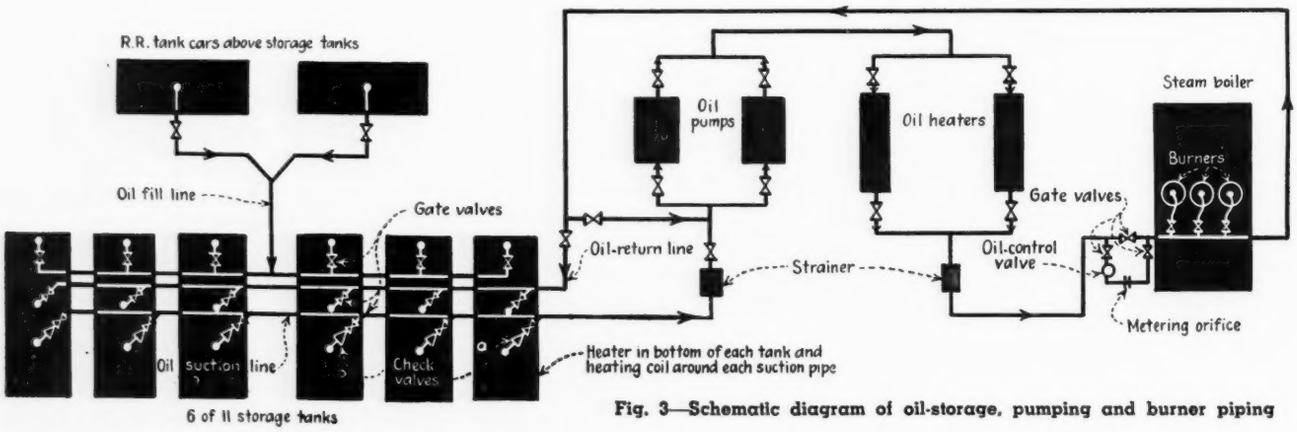


Fig. 3—Schematic diagram of oil-storage, pumping and burner piping

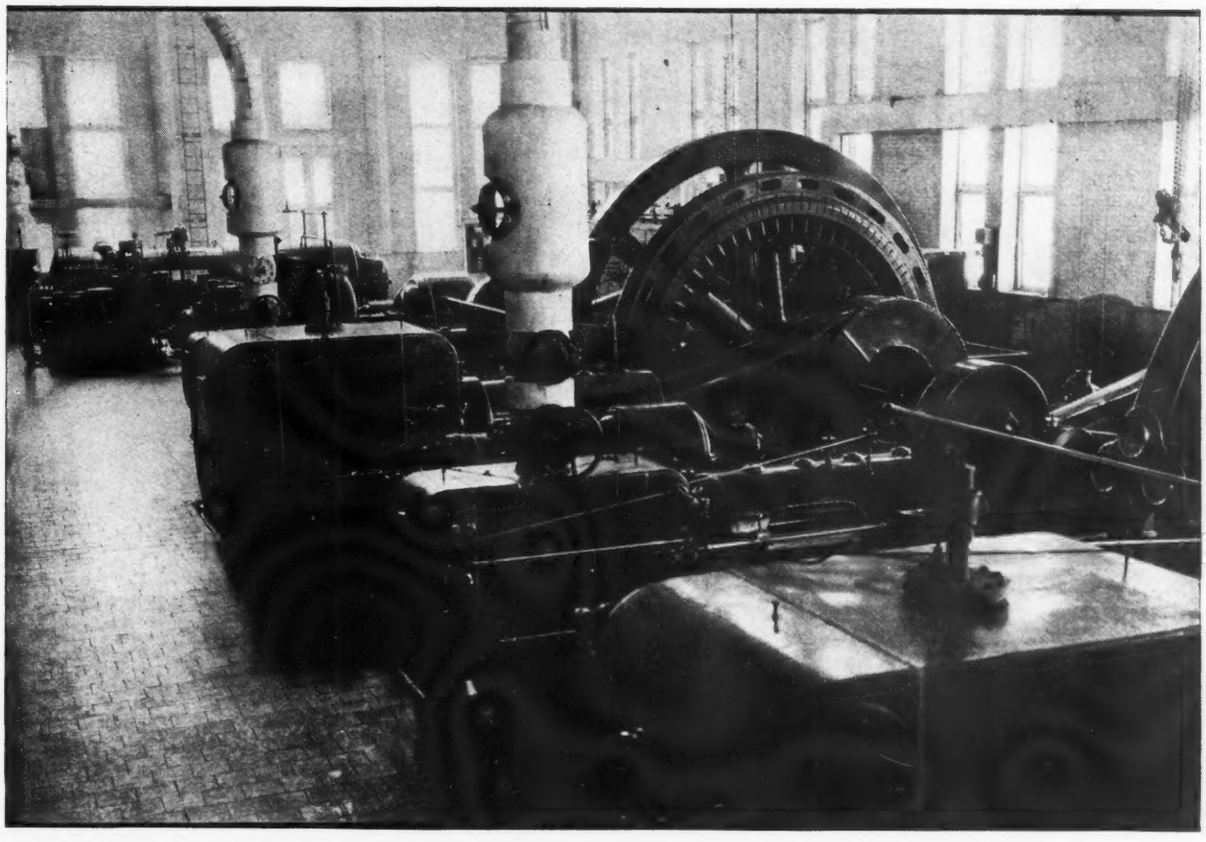


Fig. 4—In this power plant are 6,875 kw of capacity, of which the two main units are a 2,500-kw condensing turbine bled at 15 lb and an 1,875-kw backpressure turbine

to all departments so that each is charged for what it uses. These meter readings and those in the power plant provide the necessary information on which exhaustive engineering studies are based to meet the demands for power, heat and other services in the most economical way.

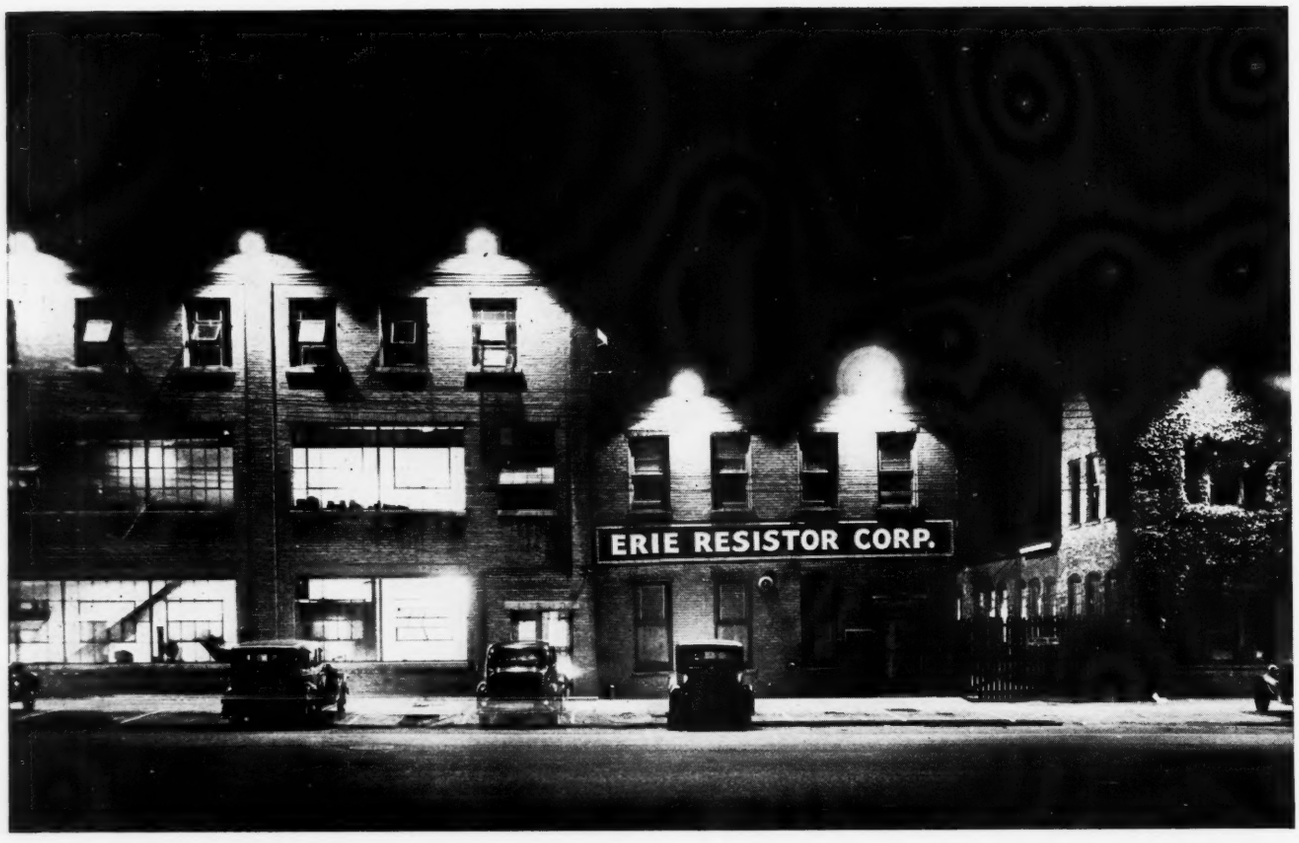
Savings

Benefits derived from these changes and improved operation are difficult to evaluate into dollars saved. But, in the power plant, evaporation has been increased approximately 25%. In the same period, turbine water rate decreased over 25%, when proper credit is given for heat in steam bled to process and for other savings anticipated. These and other improvements have effected a saving equivalent to about 33% of present fuel used. Many other large savings have been realized also, in both power plant and mill operation as a direct result of the modernization program and, the power plant is now operated as an integral part of the business.

For information and assistance in the preparation of this article, *Power* is indebted to E Wadsworth Stone, research and consulting engineer for the company, Earl Ridley, plant engineer, and A G Knight, chief operating engineer at the Thompsonville plant.

NEW EQUIPMENT IN THOMPSONVILLE POWER PLANT BIGELOW-SANFORD CARPET COMPANY

Automatic combustion control	Hays Corp
Oil burners	E L Wolley Co
Duplex oil pumps	Warren Steam Pump Co
Oil-pump lubricators	Manzel Bros Co
Rotary oil pump	Quimby Pump Co
Oil heaters	Ross Heater & Mfg Co
Oil-pressure and temperature controls	Leslie Co
Oil strainers	Elliott Co
Safety valves on oil pumps	Crosby Steam Gage & Valve Co
Valves in oil lines	Chapman Valve Mfg Co
Regulator valves on oil lines	Coppus Engineering Co
High-pressure and low-pressure valves	Chapman Valve Mfg Co
Reducing valves	Leslie Co
Reducing valves	Mason-Neilan Regulator Co
Traps	E C Squires Co
Piping contractor	E F Keating Co
Pipe insulatiton	Johns-Manville and Insulation Co
Feedwater-deaerating heater, capacity 350,000 lb per hr	Cochrane Corp
Boiler meter and control board	Hays Corp
Steam-flow meters and master pressure gage	Cochrane Corp
Boiler-load indicators	Hays Corp
Oil-pressure gages	Crosby Steam Gage & Valve Co
Oil-pressure gages	Ashton Valve Co
Oil-flow meters	Buffalo Meter Co
Industrial thermometers	Consolidated Ashcroft Hancock Co
Temperature recorders	Taylor Instrtument Cos
Temperature recorders	Hays Corp
Dial thermometers	Precision Thermometer & Instrument Co
Oil-level indicators	Foxboro Co
Oil-level indicators	Liquidometer Corp
CO_2 indicators and draft gages	Hays Corp
Power-generating unit: Turbine, 1,875 kw (90 pf); 2,400 rpm; throttle steam conditions, 180 lb g, 505 F total temp; exhausting at 15 lb g backpressure; directly connected to 2,083 kva, 3-phase, 40-cycle, 600-volt generator	General Electric Co
Backpressure governor, generator air cooler, exciter, motor-generator, switchboard panel and oil switch	General Electric Co
Air-cooler water pump	Warren Steam Pump Co



Double-Acting Dollars

When Diesels Do Heating

Erie Resistor Corp cuts its power bill with two diesel sets, and heating costs 65% by utilizing waste heat

By Douglas Rockwell

ERIE RESISTOR CORP., Erie, Pa., manufactures radio and industrial resistors and plastic parts. Since production consists of millions of small parts annually, upon which there is a close margin of profit, the management has found it necessary to effect every possible saving in production.

Cost of purchased electricity was considered too high, and installation of steam equipment offered no prospect of relief. The company, then, called in Fairbanks-Morse engineers to consider the application of diesel power in the factory.

The plant survey was complicated because of a contemplated expansion program which called for doubling building capacity and installation of much new equipment. Also, the management wanted to utilize waste heat from the engines to cut down heating costs. But through load tests and a study of building plans, the engineers were able to recommend a complete power plant and specify the location of heating radiators, pipes and other details.

Diesels

In the power house, converted from one end of a warehouse adjoining the plant proper, were installed a 75-hp and a 150-hp Fairbanks-Morse diesels, each direct-connected to 3-phase, 60-cycle, 240-volt ac generators and V-belt driven exciters. Space is available for a third unit in the future.

Equipment used in connection with operation of the engines and generators consists of a 2-panel switchboard with necessary instruments and controls, Esterline kilowatt load chart, Esterline automatic load-relay-operated ammeter which sounds a bell when load change necessitates starting or stopping an engine, and two Sims exhaust boilers. In the engine room also are the factory compressors, and a small General Electric oil-fired hot-water boiler, thermostatically controlled, for superimposing additional heat on lines from the diesels to the office. The main fuel-oil storage tank, day tanks, air intake filters and ventilated exhaust-stack supports are in the yard adjoining the power house.

Heating

Cooling water passes from the engines into the Sims exhaust boilers, then across the driveway to the main building, where it is distributed to 12 radiators. The main office, on the third floor, requires more heat than

do production bays, and when diesel waste heat is insufficient to warm it, the oil-fired boiler boosts water temperature to the desired level. Radiation in the office is by conventional wall-type, cabinet radiators, with and without blowers.

If heat available from the diesels is not enough to warm the work bays, the main oil-fired steam-heating plant is cut in. Warm air from the steam unit heaters becomes diffused with the large volume of air being circulated by the diesel-cooling radiator fans and is distributed evenly. When plant heating is unnecessary, the damper in each radiator duct is turned to divert heat outside. Radiators then become exhaust fans. Fumes and gas from lead pots, paint sprays, and molding machines, generally obnoxious in warm weather, are exhausted from the ceilings, and fresh air enters through the windows.

To make heat recovery complete, a hole was cut in the partition between engine room and warehouse, and an aeroplane-type fan installed to force heat from engines, alternators, other machinery and pipes into the warehouse, heretofore unheated. Cold air returns to the engine room through a louvre at floor level.

A conventional aquastat in the water-cooling system operates a howler in the engine room and in the main work bay if water temperatures reach the maximum safe limit.

The graphic wattmeter is permanently attached to the outgoing lines, providing a continuous record of load. In order that high load factor may be maintained, the relay-controlled ammeter sounds a bell when load drops to a point where it can be carried by one engine; the bell also sounds when load rises and it becomes necessary to place an engine back on the line or change engines.

Voltage Regulation

Because of the delicate calibrating and experimental apparatus and the electrically operated automatic equipment in the plant, close voltage regulation is demanded. The 2-panel switchboard is equipped with very fine voltage regulators, and light and power load lines are separate so that voltage drop in one will not affect the other. Instantaneous load swings of 32 kw are not unusual, requiring excellent voltage regulation.

At the time the plant survey was made, purchased power was costing 1.78 cents per kwhr, with an annual consumption of about 400,000 kwhr. It was estimated that fuel oil for operating the diesels would cost 0.503 cents per kwhr with fuel at 5.25 cents per gal. But since Dec. 1, 1936, when the engines took over the load, consumption has been at the rate of about 700,000 kwhr per year and actual fuel cost has been 0.473 cents per kwhr.

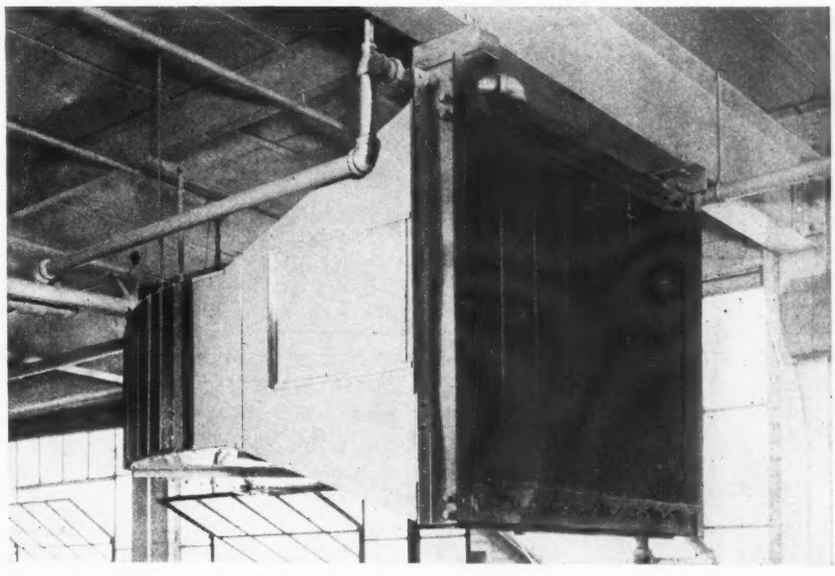
On the basis of former consumption, estimated savings would have been sufficient to retire the investment in generating equipment in five years. At the present rate of consumption, with correspondingly greater annual savings, the diesel generating units will pay for themselves in a much shorter period.

Heating Costs

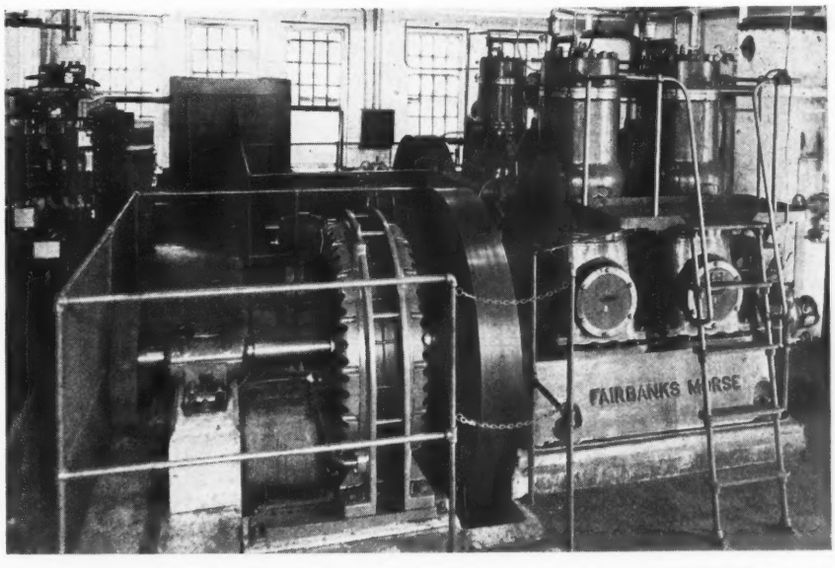
It was estimated that heat available from the engines would about equal oil-fired steam-boiler heat production for the preceding heating year and that the engines would take care of heating the new building extension. The record shows, however, that heating costs were actually reduced 64.6% from the estimated amount necessary to heat the entire plant with a typical steam-heating system.

This saving was obtained despite the fact that two months of the heating year had passed before the diesels were in operation. Heat blown from the engine room into the warehouse is of course not considered.

The plant is in continuous operation, 24 hours a day and 7 days a week. In normal operation the diesel units require and receive no more attention than is given by men on each shift who pass through the engine room in accordance with their supervisory work schedule in all departments. No addition to personnel was necessary.



Largest of the 12 radiators, using hot water from the exhaust boilers



Engine room with one 75-hp and one 150-hp FM diesels direct-connected to generators and V-belted to exciters. 2-panel switchboard and supplementary oil-fired boiler at left; one waste-heat boiler at right

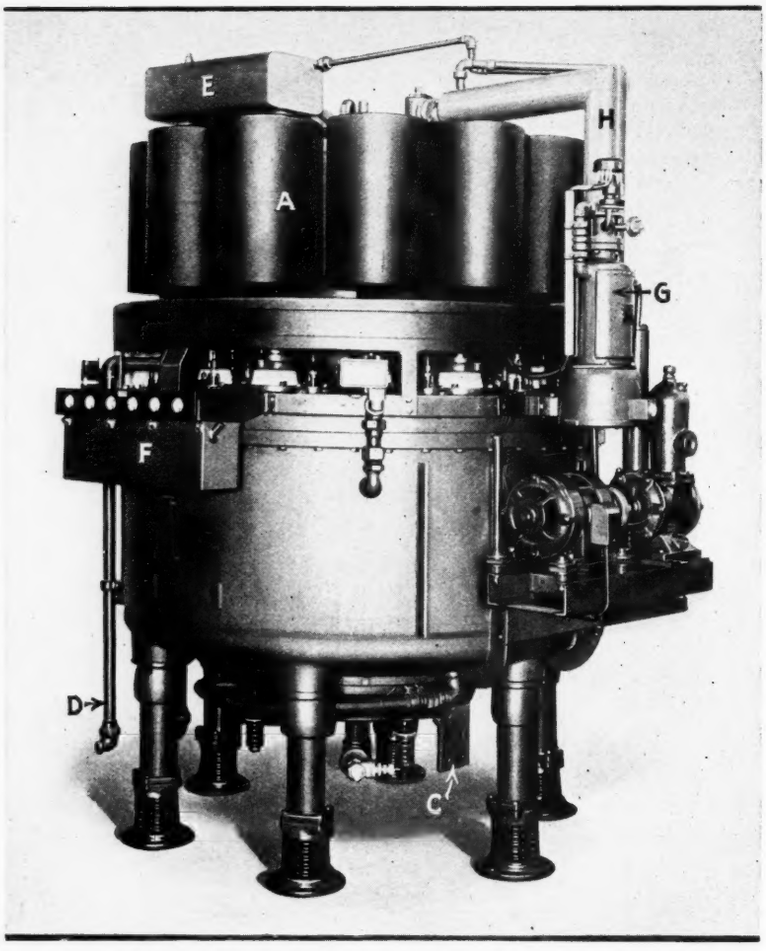


Fig. 1—Modern 3,000-kw, 600-volt, grid-controlled, mercury-arc rectifier with built-on auxiliaries. *A*, anode radiator; *B*, built-on vacuum pump; *C*, cathode terminal; *D*, cooling-water inlet; *E*, expansion tank for cooling waters; *F*, grid resistors; *G*, high-vacuum pump; *H*, water-cooled vacuum pipe

Grid Control Broadens **Rectifier Applications**

Electrostatic grids placed below the anodes of mercury-arc rectifiers have greatly extended applications by providing a means of automatically controlling output voltages, current or load

By Othmar K Marti
ALLIS-CHALMERS MFG CO

MERCURY-ARC rectifiers have been developed during the past two decades, from a small glass gadget used for charging batteries to a widely used piece of converting machinery. They are now housed in vacuum-tight steel tanks that may be 10 ft in diameter with a 30-in. wide mercury pool and having as many as 18 electrodes or anodes 10 in. in diameter, for heavy-duty railway or electro-chemical service. The starting and excitation of the arc in the tank is accomplished by means of auxiliary anodes. A vacuum running as high as one-millionth of atmospheric pressure is maintained inside the tank by built-on evacuating equipment.

Fig. 1 is a special 12-anode rectifier of latest design with low- and high-vacuum pumps and with all other auxiliaries, having a capacity of 3,000 kw at 600 volts. A transformer, Fig. 4, steps down the feeder voltage, so that the 12 secondary terminals, when connected to the 12 rectifier anodes, furnish the desired dc voltage.

Where power conversion is required, mercury-arc rectifiers have shown many economical advantages. Their principal characteristics are:

1. High over-all efficiencies for higher voltages
2. Practically constant efficiency over entire load range
3. Small space requirements
4. Light weight, require no special foundation
5. Low operating and maintenance costs

6. Insensibility to disturbances on ac-supply system
7. Immunity to chemical fumes, metallic vapors, dust, moisture
8. No synchronizing necessary
9. Can be operated on any system frequency
10. High dc voltages possible
11. High instantaneous overload capacity
12. Possibilities of cooling entirely by circulating water
13. Adaptability to automatic and remote control

Electrostatic Grid

Application of an electrostatic grid for voltage control greatly extended mercury - arc - rectifier applications. With the grid element located between anode and cathode, the dc voltage or current output can be regulated to obtain any desired characteristic without loss of power. By means of a voltage or a current regulator used with the grid control, compounding of rectifiers for railway services and constant-current regulation for electrochemical applications has been made possible. Voltage and current supply for plate circuit of several radio transmitter stations of large power capacity are also successfully regulated and controlled by this means. Studies and tests show that grid control makes it possible to use rectifiers with variable-speed drives as any desired speed characteristic can be obtained with dc motors. It also permits the reversal of power and therefore recuperation of energy through regenerative braking. Large-scale tests have demonstrated the practicability of inversion of dc power into ac power, frequency changing (network-coupling), etc.

The grid also makes it possible to use the rectifying device to obtain a commutatorless motor, to convert low-frequency power into high-frequency and to electronically clear faults in circuits by high-speed interruption, in case of shorts or other disturbances. Naturally, to obtain these results, operation of the grids and control equipment must be highly reliable.

Fig. 2 shows a 6-anode mercury-arc rectifier with transformer connected to a separate excited dc machine. The grids, located below the anodes in the arc paths, connect to a dc source through resistances r and r_1 respectively. A small synchronous motor SM with a distributor switch D and a dc generator G feeding a potentiometer circuit controls the electrostatic grids. This type of control was chosen for this explanation since it permits a simple analysis of the working principle of electrostatic grids. In practice, however, static-control equipment is usually employed.

Fundamental Principle

Let us begin with the fundamental principle of rectification (ac to dc) and then include briefly the function of the grids. In a rectifier without grid control each anode will ignite and carry current during the time it is at the highest positive ac potential in relation to the other anodes. Fig. 3*A* shows the resulting dc voltage wave VR which is the average of the sine-curve sections, e_1, e_2, e_3, etc., and is obtained without grid control. Under these conditions, each anode carries current only during the middle third of each half cycle.

As shown in Fig. 2, all grids are normally energized with a blocking voltage E_b. If the brush of the distributor D is driven synchronously by motor SM and relay S is closed, then the grids of the 6 anodes obtain synchronous positive voltage impulses resulting in successive firing of the anodes. In Fig. 3*A* are shown the positive impulses for a distributor setting of zero degrees and the resulting voltage is indicated by VR. Opening relay S deenergizes the brush of distributor D. Then, all grids are negatively charged so that first one anode and then another will cease firing as the current passing through them becomes zero. The rectifier is then completely blocked and acts like an open breaker.

The electronic control therefore makes it possible to regulate, within a small portion of a cycle, the flow of current between cathode and anode by the expenditure of only a small amount of power. After the current is once established, however, its flow cannot be influenced until it again passes through zero. Fig. 3*B* shows what happens to the dc output voltage wave if the handle of distributor D, Fig. 2, is shifted by an angle of about 60 electrical degrees (angle of delay $\alpha = 60$ deg). Firing time of each anode is delayed by 60 electrical degrees, as indicated, and each anode carries current only during the last

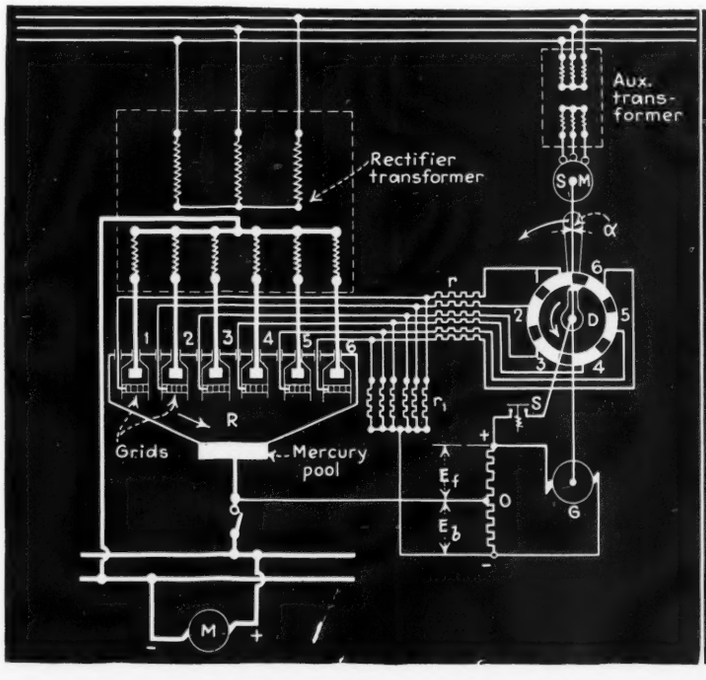
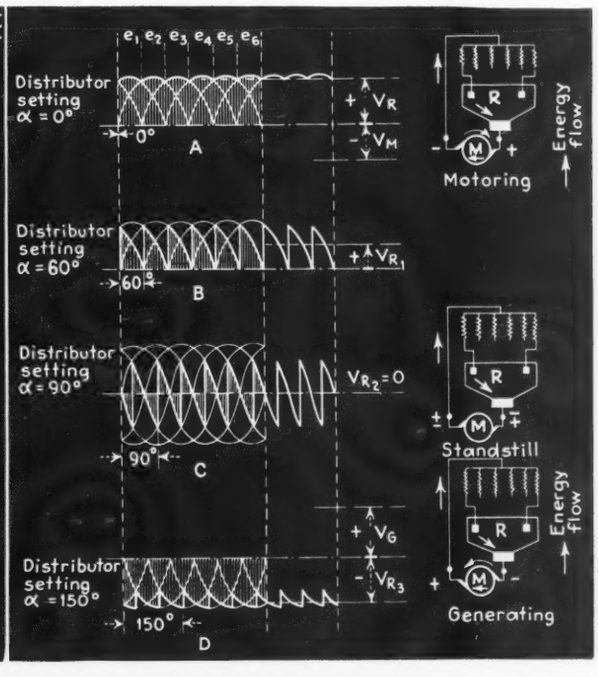


Fig. 2—Simplified connection diagram for a 6-phase rectifier with grid control



Figs. 3A to 3D—Principles of operation of a 6-phase grid-controlled rectifier and inverter

⅓ of each half-cycle. Consequently, the average output voltage VR_1 obtained for such a setting is only 47% of the normal voltage. In Fig. 3*C* firing is delayed 90 electrical degrees and therefore the average output voltage VR_2 becomes zero.

Actually, at zero output voltage on inductive loads, the rectifier is still delivering voltage some positive and some negative, as in Fig. 3*C*. However, the integrated values of these positive and negative voltage waves are equal, and cancel, so that average output voltage of the rectifier is zero. During the brief intervals occurring every cycle when negative voltage is delivered by the rectifier, the unit is actually acting as an inverter. Consequently, if the firing point of the anodes is delayed still further, as in Fig. 3D, the negative-voltage component will become larger than the positive-voltage component. Under these conditions the rectifier operates as an inverter, and feeds dc energy supplied by machine *M* into the ac network. It is easily possible to have all the control features carried out automatically. The controlling elements may be caused to function by either voltage, current, or load.

For such grid-controlled mercury-arc rectifiers, new fields of application are constantly opening. Applications which are far past the experimental stage will be discussed in another article and attention called to trial installations being made or considered.

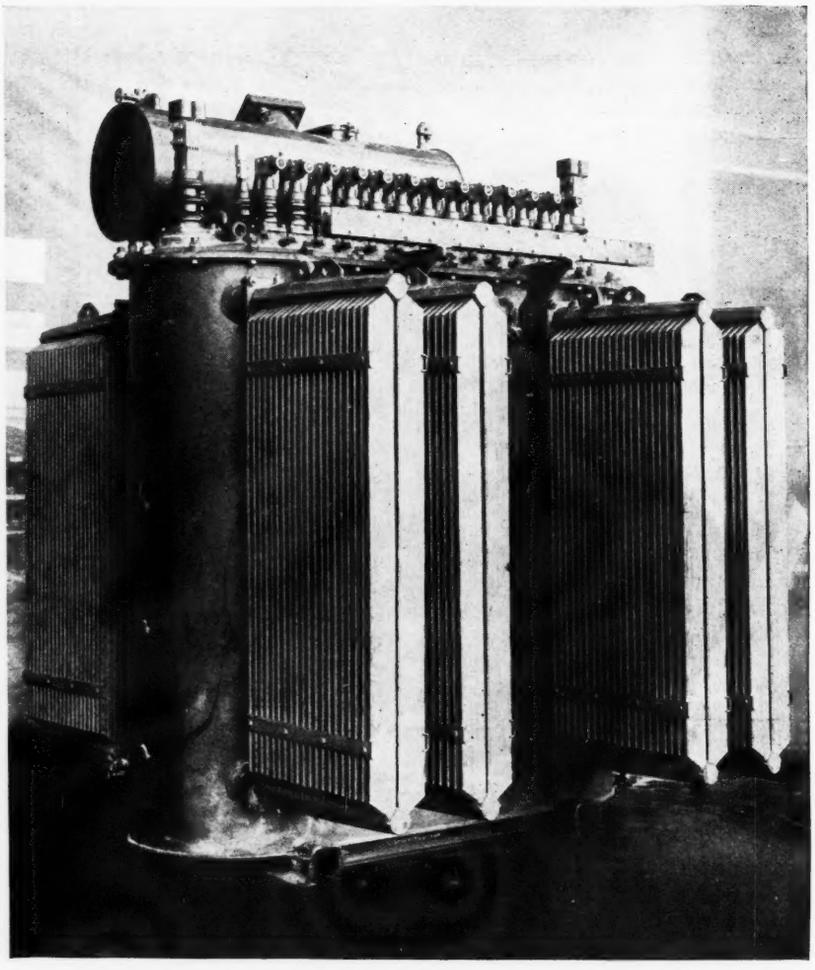


Fig. 4—Modern 12-phase rectifier transformer, having a secondary rating of 3,470 kva at 256 volts, for use with two mercury-arc rectifiers

Exhaust Lines

By E. J. Tangerman

At the Babcock & Wilcox plant in Barberton, Ohio, they can weld 600,000 studs per month on stud tubes. Studs are resistance-welded on before tubes are bent or machined in any way. B&W has its own equipment for making coated electrodes for automatic-welding machines, a pretty tricky job when the X-ray is to inspect the finished joints. They now use dc for small parts, ac for big drums, because dc sets up a field at the opposite end of the drum, causing spatter and craters.

A new and very complicated switch was ready for test, so the engineer on duty threw her in. Immediately, the air was filled with flying pieces. He waited until they landed, then walked over to the 'phone booth and laconically called his superior. "Boss," said he, "You better come down. I just threw in that new switch and hit the jackpot!"

Buffalo General Electric has just installed air conditioning in its 12-story office building, involving an unusual system of air distribution. Parts of the main and mezzanine floors have light-reflecting, sound-absorbing ceilings which consist of 1x2-ft "panes" containing 4,000 tiny perforations per sq ft. Behind this is a layer of Rockwool and over this in turn is an air space or plenum chamber. Conditioned air enters this space then passes through the sound-absorbing Rockwool and out at the perforations. Such a ceiling eliminates drafts, gives greater uniformity in air flow and temperature, yet absorbs 85% of noise and reflects 67% of light impinged on it.

One of the larger central stations has a wind-velocity indicator on its roof. When wind velocity gets up around 100 mph, it blows a whistle. Operators in the coal towers on the exposed trestle then set rail clamps and get down out of there—the engineers are just a leetle afraid that the towers may be gone with the wind.

Standard Oil of Indiana got M W Kellogg to build, at Kellogg's Jersey City plant, a crude-oil still 15 ft in diameter by 80 ft long, weighing 460,000 lb, that comes close to the old story of the man who built a rowboat in his basement, then couldn't get it out. This tank is too big for any freight car or for any ship small enough to pass through the Erie and Welland Canals. The plan now is to cut a hole in the end of the plant and slide the tank out to two flat cars which will carry it to New York Bay. There it will be floated and a tug will tow it 1,371 miles to Whiting, Ind. The route goes up the Hudson, through the Erie Canal to Lake Ontario, through the Welland Canal, Lake Erie, St Clair River, Lake Huron, through the Soo, and south on Lake Michigan to Whiting.

The phone rang in the large-power-plant superintendent's office. It was the city smoke inspector, asking if he couldn't come over for a visit. "Come ahead!" said the supe. The visit was nice, but uneventful, until the inspector suggested a stroll up the street. It was summer, so they strolled in shirtsleeves. After a few steps, the inspector, grinning a little, brushed his sleeves. The supe did likewise. A little farther on, the inspector ran a finger around inside his collar to relieve the itching. The supe did likewise. And then, the inspector, still grinning, turned around and handed the supe a summons. The whole thing was in fun, except the summons. It was real.

So He Blamed the Treatment

Because it was an easy out. Here a service man tells how they've calmed many tempests in powerplant teapots

By H A Gustin
NATIONAL ALUMINATE CORP

.....found 100-odd employees

IF THE CHIEF ENGINEER'S mother-in-law develops water on the knee, or if his brother's chickens die with hoof-and-mouth disease, your water treatment will be the cause of the trouble." Such were the words of wisdom imparted a good many years ago, by my then and present boss, to me when I embarked on the career of treating water. Truer words were never spoken.

When Is Soda Not Soda?

"Long distance calling."

"Put them on."

"Hello, hello. Say, that last barrel of treatment you sent us is no good."

"What seems to be the trouble?"

"Well, we can't get the water soft. We've changed the lime and soda ash, but the water just won't get soft, and we can't run the mill because the woolens come through yellow. It must be the water. How soon can you send a man down here?"

"We'll have a man there in the morning."

The following morning a service man arrived at the plant and found about 100-odd employees around the front entrance. A little questioning disclosed the fact that the mill had been down for several months. At last enough orders had been received to warrant running again, and after two days of operation, during which time the woolens "came through yellow" the plant was closed once more. It would reopen as soon as "good water" could be produced, and the employees were gathered around waiting for "good water."

The water at this plant was treated with lime, soda ash and liquid sodium aluminate in a cold-process continuous softener, the lime being fed as a saturated solution, the ash and aluminate from a single tank. A treated-water test indicated a lime deficiency. The required theoretical increase in lime was made, and since from eight to ten hours was necessary for the change to show up, the mill workers were told to go home and come back the following day.

Early that evening, the increased lime dosage showed up. Hardness had decreased by one grain, but it was still too high. There now appeared to be a deficiency of soda ash. A soda-ash increase was made, followed by a 10-hr. wait for results. Results were not forthcoming. The water had correct lime-soda treatment, but hardness was still high. Under such conditions, and with this particular softener, there was but one answer: the sodium aluminate dose was insufficient for proper softening. Consequently an increase in aluminate was made. When the water thus treated came through, it showed no improvement whatsoever. Some of the disgruntled and disappointed employees suggested that the service man might have stayed in Chicago.

The softener was dumped, lime saturator dumped, chemical tank cleaned out, proportioning equipment checked and a fresh start made with the same chemical dosages. Still no results! The water showed no improvement.

"What kind of lime are you using and how long have you had it?"

"Here it is—we just received a new supply."

Investigation showed it to be of an excellent quality.

"What about the soda ash?"

"The same that we always used."

"Let's take a look at it."

"Say Bill, where's that soda ash you're using? This fellow wants to see it."

"Here you are, mister. This is the same soda we wash the floors with. We had a barrel on hand and thought we'd use it up in the softener. I guess soda is soda, isn't it?"

Our problem was solved.

Liquid sodium aluminate is substantially aluminum hydroxide held in solution by caustic soda. This particular washing soda contained sodium bicarbonate. Caustic soda reacts very readily with sodium bicarbonate to form sodium carbonate, which is soda ash. The sodium bicarbonate in the washing soda was reacting with the caustic soda in the aluminate solution, precipitating aluminum hydroxide in the chemical tank. No sodium aluminate was reaching the main body of water, so it had no chance to do its work therein.

A railroad water softener some twenty miles away was the nearest known source of soda ash. A hurried trip was made over there, a bag of soda ash borrowed, the softener dumped and chemical tank cleaned, and a fresh start made. Ten hours later a sparkling clear water with less than half a grain hardness was being produced. The mill resumed operations, the employees went back to work, the woolens came through soft and with perfect color, and the service man returned to Chicago.

Agitators at Work

A large central station was pretreating for evaporators in an intermittent softener with lime, soda and iron. Hardness reduction below six grains could not be obtained. Treated water on the filters was so turbid that one could not see through it; consequently, results were not entirely satisfactory.

An order was placed for a supply

.....Let's take a look

of sodium aluminate, and a service man was sent to the plant to see that it was used properly. Upon his arrival, he was greeted by the man in charge, taken out to the water plant and shown the type of water being produced. It was about as bad as it could possibly be. The conversation was substantially as follows:

"How long do you settle the tanks?"

"Oh, from four to six hours."

"Can you see the bottom of the tank by that time?"

"Well, I should say not. You can't see the bottom of the filter."

"How would you like to see the bottom in one hour with a half grain of hardness?"

"That would be great, but I don't think it's possible."

"You give us a free hand for a day or two and we'll show you something."

"The plant is yours. If you want anything I'll be back at the office."

The tank which had just been treated was tested, the raw water was tested, the theoretical chemical changes were made, aluminate replacing iron, agitation started, and the tank filled. After it had settled for an hour or two it was still extremely turbid. A test of the water indicated just one thing—lack of agitation.

A trip to the top of a tank which was empty, ready for charging, indicated nothing unusual. A call to the man below brought a strange face to the door of the filter house.

"Where is the other lad?"

"He went up to the office for a minute. Can I help you?"

"Perhaps you can. What do you do around here?"

"I'm an electrician."

"Can you turn the agitator on down there?"

"Sure thing. I'll do it for you."

He did so, and at a signal a minute later, turned it off again."

"Say down there? How much of a job would it be to make this thing run the other way?"

"No trick at all. Just change a switch back of the button. I can do it in a minute."

"O. K. Make that change and then start it up again."

Two minutes later:

"How's that, mister?"

"That's just fine. You can shut it off now and leave it that way."

The mechanical agitation in this plant consisted of a paddle revolving in the bottom of the tank. It was on an angle to throw the water and chemicals upward, providing an excellent mix. If running the wrong way, it had practically no effect on the water above it and provided no mix whatsoever.

A few minutes later the operator returned, was given the chemical charge and treated another tank. An hour after agitation stopped, a test of the water showed half a grain of hardness. The water was as near right as it could be.

"How would you like to see the bottom of the tank?"

"You wouldn't kid me, would you?"

"Let's go up on top and take a look."

Much to his amazement the tank was clear and the bottom was plainly visible. His eyes bulged as he said: "That sure is great stuff, mister. That sure is great stuff."

"Snakes in the Superheaters"

"Hello, is that you, Chicago?"

"Yes, what can we do for you?"

"We're losing superheater tubes. They're plugged with stuff that looks like snakes. We need help right away. Do you think you can locate the trouble?"

"That's our business."

"Can you send a man down here on the sleeper tonight?"

"Yes, we'll have a man down there first thing in the morning."

This conversation took place between our office and a plant that had used our consulting service for a number of years. The plant had an extremely soft water that required no treatment for scale prevention, but did require corrective treatment for protection against embrittlement. Our job had been to make periodic boiler-water analyses and report as to the embrittling condition of the water, recommending any necessary changes in the sodium-sulphate dosage. Sodium sulphate was bought in the open market and we were not supposed to interest ourselves in steam quality, corrosion, scale, etc. The plant had never had any of these troubles in the past.

.....plugged up with snakes

Early the following morning a man called and spent the entire day checking every possibility. The trouble had been noticeable, off and on, for just the past couple of months. Boiler rating had been increasing gradually over a number of years. It was now very high, but the load was even and there was no apparent reason for the trouble.

The results of some 150 boiler-water analyses over a period of three years were plotted on a graph. It was shown that the dissolved-solids concentration had been building up from an average of 142 grains per gal. two years ago and 165 grains one year ago to an average of 192 grains for the past two months. Trouble had been noted only during the past two months. Did not these two go together? They did. It was determined that the critical concentration was 175 grains per gal.

Control equipment was installed to maintain the concentration below the critical point. Our laboratory has continued to make regular analyses since then, and in no instance has a sample shown a concentration beyond the critical point. No more superheater trouble has been encountered.

Will Soda Ash Cause Foaming?

"Gentlemen:

That last shipment you sent us is not giving the same results as former shipments. Our water tests the same, but we have lost all of our superheat. You had better send a man down here to look things over.

Very truly yours"

A few days later a service man arrived at the plant. Water for boiler feed was treated in a lime-soda-aluminate softener and results had always been excellent in the past.

"What seems to be the trouble?"

"Look at these superheat charts. They show saturated-steam temperature. Here are some from one, two and three months back showing we always had 45 to 50 F superheat. Maybe we're using too much soda ash. Will soda ash cause foaming?"

"If you use too much, it sometimes will. Let's see your water tests."

"Here they are. Hardness hasn't been above half a grain from the softener for two weeks. That looks pretty good, doesn't it?"

"Yes, it does. Let's see the plant."

A sample of water was drawn from the filter and a test on it showed 1.5 grains of hardness.

"Say, Bill, run a test on this sample."

Bill's test showed half a grain.

"Here's your trouble, Chief. Bill's soap shows half a grain, mine shows a grain and a half. That water needs more soda ash."

A few hours after the soda-ash increase was made the filtered-water hardness had come down to half a grain. That meant one grain per gallon less potential sludge going to the boilers. With 20 concentrations, that meant that the sludge content of the boiler would soon be reduced 20 grains. In a plant operating at high ratings, and concentrations near the critical point, 20 grains of sludge means the difference between good steam and poor steam.

Within 24 hours some superheat started to show up. Soon it was showing 50 F on the chart.

"You'd better get new soap, Chief."

"Take an order."

.....service man leads enjoyable life

"That treatment you sold us a few weeks ago is no good. Our boilers started to foam this morning and we had to cut them out altogether, but they're still foaming. You better get over here quick."

A short time later a service man arrived at the plant and he could hear the high- and low-water whistles nearly a block away. The boiler room was full of steam, the water was out of sight, one man was at the blowoff valves and another at the pumps.

The plant in question was using internal treatment and it furnished steam for heat and process to a number of other plants in the vicinity. The temperature on the day in question was twenty below zero.

"Draw a sample of boiler water."

"Here it is, we've been waiting for you."

A rapid analysis showed an alkalinity of something much higher than 3000 grains per gal.

"Chief, you're in trouble. Can you shut the plant down?"

"If we do, everything will freeze up and we and our steam customers will lose thousands of dollars. We must keep her running."

"How often are you blowing down?"

"Every five minutes."

"Increase it if possible. Draw a sample of heater water."

The heater water was tested.

"Bypass the heater and feed raw water to the boilers. Draw a sample of return condensate from your own system as well as one from the systems of each of your customers, and label each sample."

The above had taken but five or ten minutes. Within another ten minutes each condensate sample was checked and all but one had alkalinity of about 100 grains per gal. That one ran into the thousands. The plant from which this sample came was contacted and the trouble then found.

A line had frozen and burst in an underground tank of caustic soda, unknown to the owner. Hundreds of gallons of caustic had come back as returns from this plant, had gone through the heater and into the boilers. It was several days before this plant needed any more treatment.

Taking it all in all, a service man really leads an interesting life.

A Gas-Engine Steam Generator

Bethlehem Steel Co tried a waste-heat boiler on one of its 4000-kw gas engines. The boiler worked so well that seven more are going in. Here are facts and figures

By T A Lewis*

COMBUSTION ENGINEER
BETHLEHEM STEEL COMPANY

GAS ENGINES, first introduced to the steel industry at Lackawanna Steel Co about 1900, were of the 2-cycle, double-acting, twin-cylinder type. Later developments brought 4-cycle units also, but early operation was beset with difficulties. Gas cleanliness was not fully appreciated, so abrasives from partially cleaned gas caused excessive wear on cylinders, made valves stick, and closed ports. Now, however, blast-furnace gas contains less than 1 grain of dust per 100 cu ft.

Bethlehem gas engines, designed and made locally, have been in operation since 1909. First units were 4-cycle, double-acting, twin-cylinder engines, driving 1500-kw dc generators at 150 rpm. They were in service until 1927, when power requirements no longer included this large block of dc. Gas-engine blowers, put in operation in 1909, are still functioning. These older units have been supplemented with four 4-cycle, double-acting, 2-crank, tandem-scavenged and supercharged engines, operating 98.5% of the time, and delivering 5000 hp (3560 kw) at 96% electrical efficiency.

Improvement in mechanical operation of the gas engine led to development of a satisfactory waste-heat boiler. European practice involved firetube boilers and economizers, giv-

*An abstract of a paper before the Chicago Convention of the Association of Iron & Steel Electrical Engineers, Oct. 18–22.

TABLE I—HEAT BALANCE OF 4000-KW GAS ENGINE & WASTE-HEAT BOILER UNIT

	M BTU.	%
1. Net power generation	12,683	27.16
2. Steam generation	13,983	29.94
3. Loss to cooling water	12,040	25.78
4. Loss to boiler blowdown	913	1.95
5. Loss to sensible heat in stack gas	4,691	10.04
6. Loss to CO in stack gas		0.00
7. Radiation and unaccounted for	2,398	5.13
	46,708	100.00

Heat Balance of Boiler

1. Steam generation	13,983	70.51
2. Loss to blowdown	913	4.60
3. Loss to sensible heat in stack gas	4,691	23.66
4. Radiation and unaccounted for	243	1.23
	19,830	100.00

Engine Heat Balance

1. Net power generation	12,683	47.18
2. Loss to cooling water	12,040	44.80
3. Radiation, mech. & elec. losses	2,155	8.02
	26,878	100.00

ing lower installation costs and in accordance with boiler development at that time. We first planned to follow the same practice, but found that clean flue gas and the decision to have final flue-gas temperatures of 350 F and feedwater temperature of 200 F eliminated the firetube economizer. A comprehensive study yielded the boiler design of Fig. 1.

Trends

It may be of interest to digress here for a moment and point out the trend of steel-mill thinking with regard to gas and gas engines with waste-heat boilers. Blast-furnace gas has such a low calorific value that steel plants have been slow to utilize it for other than stove and boiler purposes. A 500-ton furnace will supply about 2,000,000 cu ft of gas per hr above its own requirements, and due to high steam demand, the tendency is to use the gas under boilers. However, increasing fuel prices have made it economical to use the gas in engines and metallurgical furnaces before using it under boilers.

The amount of steam which can be generated in a waste-heat boiler when supplied with a definite quantity of gas at a given temperature depends upon boiler size and allowable draft loss. In practice, the theoretical limit of recovery is the heat in the gas between the temperature at which it leaves the engine and the temperature of saturated steam at the desired operating pressure, or the feedwater temperature if economizers are provided. It is not practical to build a boiler that even closely approaches this condition, but it is economical to design for boiler efficiency up to 70% if it is permissible to build up a draft loss of about 4 in. of water or higher through the boiler.

In 1935, Bethlehem Steel Co installed its first waste-heat boiler on one of the 4000-kw engines at the Bethlehem, Pa., plant. So successful was this installation that four complete units followed, and now three additional units are under construction. These waste-heat boilers, equipped with economizers, are the first units of their kind to be used for such service in this country. They generate more steam for the steel plant, which still requires a large supply of steam, although the trend is toward complete electrification. Steam and all other heat requirements, Fig. 2, involve a large quantity of purchased fuel, in the form of electric power, oil and coal. Waste-heat distribution represents 6.1% of the total, an amount that influenced our application of waste-heat boilers on gas engines.

Application of a waste-heat boiler on the gas engine is simpler than on a metallurgical furnace, because no auxiliary equipment is needed, such as fans, no infiltration of air occurs because the boiler is on the pressure side, and clean gas and engine-cylinder pulsations eliminate daily external cleaning of tubes.

Flue gas enters the waste-heat boiler at 1200 F and leaves at 350 F. Further recovery, in the form of hot water, can be made from this flue temperature, but local conditions determine whether such recovery is justifiable.

Fuel Distribution

The fuel-distribution sheet, Fig. 2, indicates the value of gas-engine waste-heat boilers, compared with the total plant load. Successful operation of the units governs the amount of boiler fuel purchased. Table I

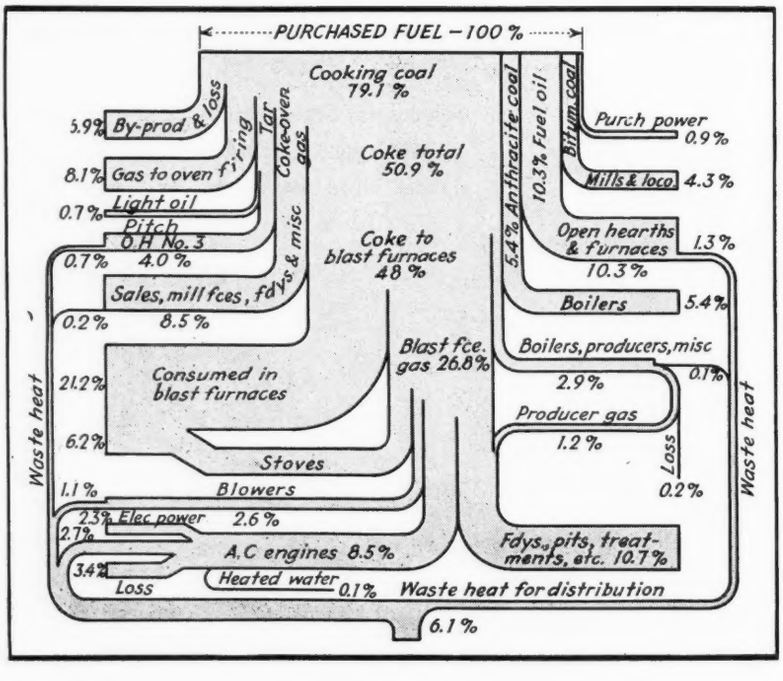


Fig. 2—Fuel distribution flow sheet for the Bethlehem plant. Error in top center of drawing shows "cooking" for "coking" coal

gives the heat balance of the gas engine and waste-heat boiler.

All modern highly improved steam-power schemes are excellent, but to avoid their complications, the simpler gas engine and waste-heat boiler combination is more advantageous with a load of the type found in the steel industry.

As an illustration, a comparison has been made between the present operating gas-engine units, equipped with waste heat boilers, and a good turbine, Fig. 3.

Operating Results

The present gas-engine waste-heat boiler unit has demonstrated clearly what operating results are attainable. For further improvements it will be necessary to go to larger units. As far as advantages are concerned, units of twice the present size are comparable with larger turbine units. Such a unit should be able to generate on the shaft the equivalent of 8000 kw, with an additional 2600 kw from waste-heat-boiler steam, and is well adapted to a steel plant with an electric load of 20,000 kw or more. For a smaller power load the present unit is ample. Our first unit, on No. 8 engine, gave these results in its first year of operation (1935): operated 7803 hr, or 89.2% of the time, 3480 average kwhr generated, 13,400,000 Btu heat release per hr, 3.45 lb of steam per kwhr average. During this period, engine operation was handicapped by lack of gas due to curtailed plant operation. Under normal conditions, the unit operates on a 96% basis. The first two scavenged and supercharged gas-engine blowers operated 98.5% during their first two years of service; in their ninth year they are still as reliable.

In Europe there are gas-engine units generating in excess of 7000 kw, and gas-engine blowers delivering 135,000 cu ft of 15.6-lb air per min. Size for size, these are more efficient than our present units, because mechanical losses and losses through jacket water and radiation are smaller.

Summary

Summarizing: in steel-plant operation, the Bethlehem gas engine that has been in operation for the past 20 years, but completely renovated, has been able to compete with modern turbine units. Furthermore, application of waste-heat boilers has reduced operating cost to the extent where such a combination is the only logical one. As the size of the gas engine increases, the advantage becomes still greater. Compared with a turbine station, the gas-engine-waste-heat-boiler system requires only half the amount of fuel, for the same power output, releasing the remaining half for metallurgical furnaces. Normally, this advantage is still further enhanced due to the fact that a higher-priced fuel is used for metallurgical furnaces.

The final analysis of any scheme is the ultimate cost to the producer. The combination gas engine and waste-heat boiler can meet the initial cost of installation and give a lower operating cost. Due to the higher thermal efficiency of this combination, its advantage becomes greater with increasing price of fuel.

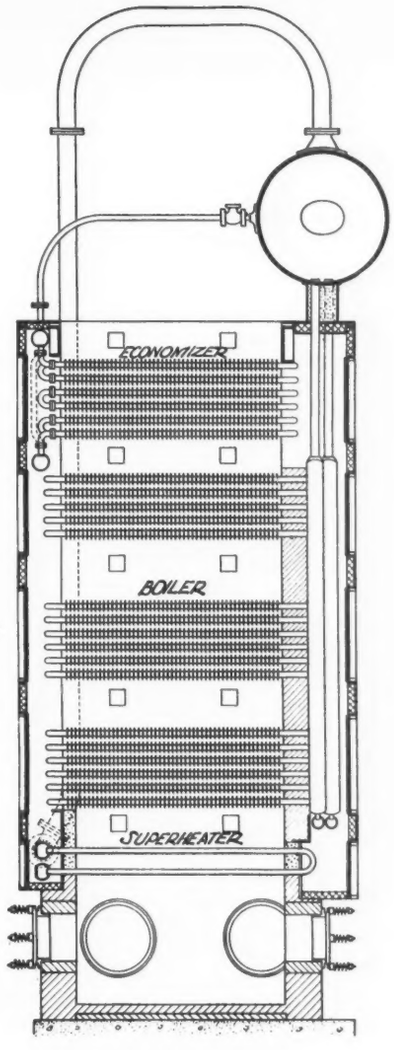


Fig. 1—The waste-heat boiler on No. 8 engine

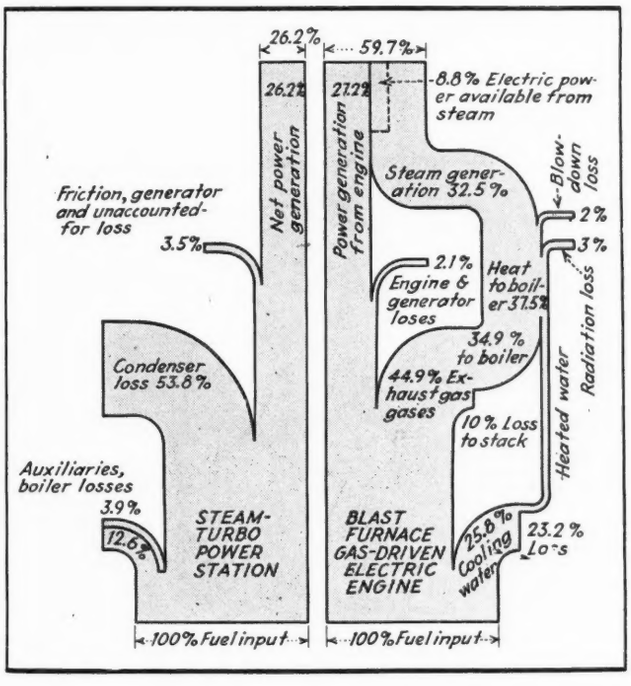


Fig. 3—A comparison of a modern high-pressure steam station and the Bethlehem gas-engine power station with waste-heat recovery

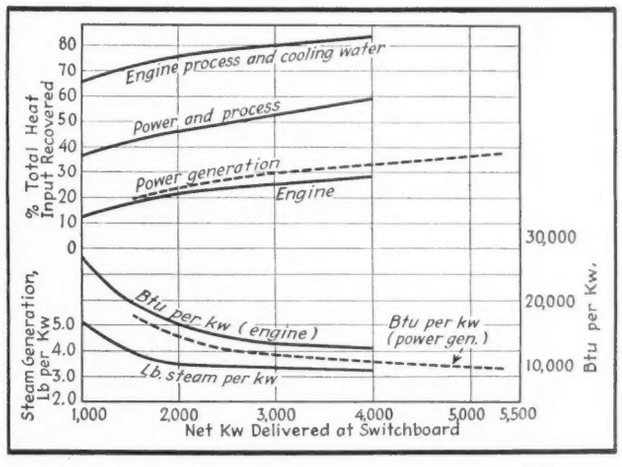


Fig. 4—Performance of the gas-engine waste-unit boiler unit

LUBRICATING SYSTEMS

Grease Cups

Greases comprise one of the major lubrication classifications. Here are five ways of applying them to bearings

By James I Clower

PROF. OF MACHINE DESIGN
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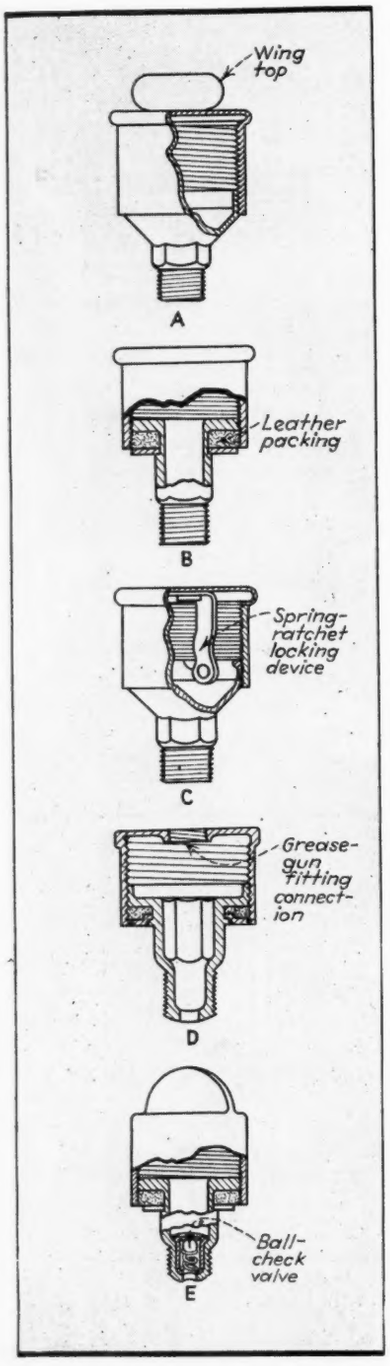


Figs. 1A to E—Typical simple compression grease cups. Figs. 2A to C—Three types of spring-compression cups that feed grease automatically

IN SELECTING a lubricant careful consideration must be given to a number of influencing factors, such as speed, bearing pressure, operating temperature, contaminating influences (dust, moisture, chemicals, air, etc), and last but not least, method of application. Many users of lubricants do not fully realize the effect that method of application has on the type and grade of lubricant to be employed for a particular use.

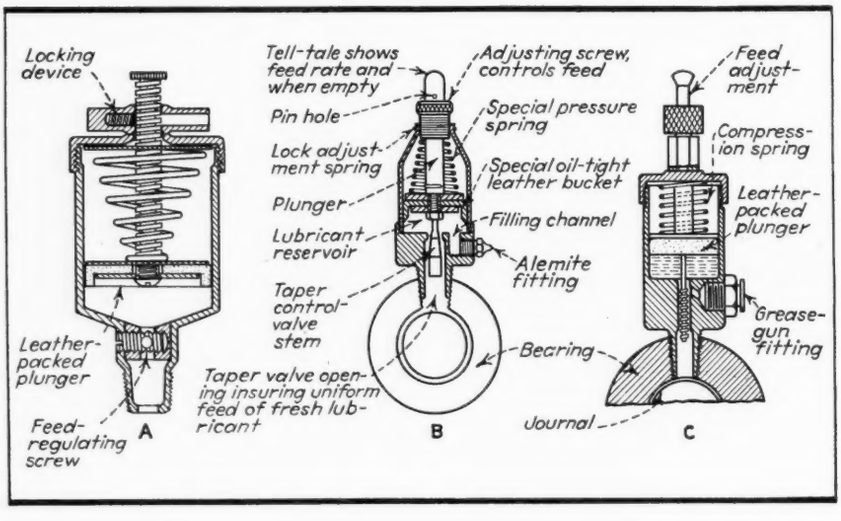
For all hand-application methods and others in which the lubricant is not used over and over a lower grade of lubricant may be used than where it is recirculated. In such methods as hand-, drop-, wick-feed, etc, the lubricant is applied to the bearing, passes through it, and then generally runs to waste. It is not required to withstand service conditions for any appreciable time. On the other hand, a continuously reused lubricant must be highly resistant to oxidation, emulsification (if water is present) and to any other deteriorating factors.

Where hand-, drop-, wick-feed, and similar methods are employed, feed is intermittent and usually irregular. As a result, the lubricant should, in general, possess a heavier body (be more viscous) than if it were continuously reused. This is necessary because the lubricant must stay in the bearing for an appreciable length of time.

For the purpose of discussion, lubricating systems may be broadly divided into grease systems and oil systems. Grease systems may be subdivided into five methods of application: (1) Hand, (2) grease-cup, (3) grease-packed, (4) grease-well, and (5) pressure.

HAND APPLICATIONS. A paddle, swab, or brush is generally used when grease is applied by hand, as is done frequently for open gears, chains, wire rope, and some bearings. In general, this method is wasteful and unreliable and involves the human element. Much more grease usually is applied than is required, the excess being thrown off and wasted. Because of an operator's negligence, equipment may operate for some time without adequate lubrication.

GREASE-CUP APPLICATIONS. This



method, an improvement over hand application, does not eliminate the uncertain human element. The compression grease cup, Figs. 1*A* to 1*E*, the cheapest and perhaps the most widely used, screws directly into the bearing that it serves. Grease is forced into the bearing by screwing down on the threaded top, which is filled with grease. Fig. 1*A* is an inexpensive design having a wing top, while 1*B* for high-temperature conditions has a leather packing to prevent grease leakage. Where vibration is severe, an internal or external friction spring, or a spring ratchet device is provided, Fig. 1*C*, to keep the cap from backing off. To facilitate refilling, this type of cup is also obtainable with a pressure grease-gun fitting in its top, as in 1*D*. For circulating pumps and other services where water is likely to back up into the cup, they are provided with a ball check valve, Fig. 1*E*.

All these cups are made with either male or female threads, and in capacities from $\frac{1}{4}$ to 22 oz. They are threaded for standard $\frac{1}{8}$-in. to $\frac{3}{4}$-in. pipe, depending on capacity.

Compression cups feed little grease except when the top is being screwed down, thus, application of lubricant is periodic. The design of Figs. 3*A* and *B* is widely used on marine and gas engines and adaptable to other machines where screw feed is satisfactory. When the T-handle attached to the piston stem is turned, grease is forced out of the cup into the bearing. As considerable pressure can be applied to the grease by means of the threaded piston, this type is adapted for forcing grease through pipes of considerable length. The design of Fig. 3*B* has a simple, spring locking device which prevents the cap from being unscrewed by vibration. The leather packing on the plunger tends to hold the piston in position and eliminate danger of grease being drawn from the bearing.

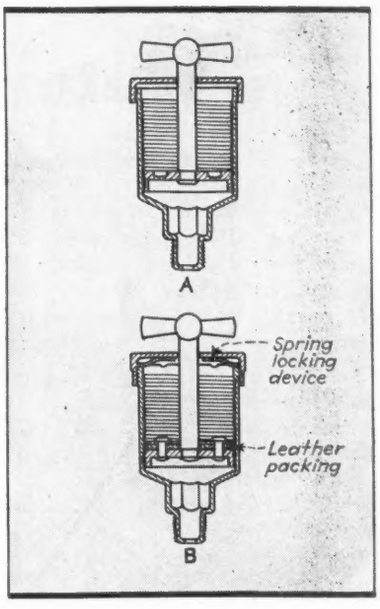
In the automatic spring-feed cups, Figs. 2*A* to *C*, a spring acting against a leather-packed plunger forces grease slowly into the bearing. Rate of feed may be regulated and the handle may be set at any position on the stem to stop the flow of grease, when desired. A spring-locking device prevents the handle from being jarred from any set position on the stem. Designs *B* and *C*, are similar to *A*, except that they are provided with grease-gun fittings, which eliminate the necessity of removing the top for refilling.

These designs require little attention except refilling and an occasional cleaning. They are especially suitable for inconveniently located bearings, and provide a fairly uniform rate of feed. They are obtainable in brass, bronze or pressed steel.

GREASE-PACKED APPLICATIONS. Frequently bearings are enclosed so that they can be grease-packed. Usually some type of grease retaining ring or seal is provided where the shaft extends through the housing. This system, if seals are maintained in good condition, insures comparative freedom from impurities that may be in the surrounding atmosphere, requires little attention and is reliable. It is frequently used for ball and for roller bearings. These bearings should not be filled more than one-third full of grease, otherwise they are likely to overheat. Fig. 4 is grease-packed, mine-car-wheel bearing and Fig. 5, a grease-packed, synchronous-motor roller bearing.

GREASE-WELL APPLICATIONS. Some bearings are designed with open tops, sides, or bottoms and are lubricated by placing grease in the adjacent well, where it presses against the revolving journal. Friction heat from the bearing melts the grease slowly to provide lubrication. Comparatively hard block greases are widely used for this type of bearing, the blocks frequently being made to fit the well. A typical block-grease lubricated bearing is shown in Fig. 6.

In some cases a perforated plate, with $\frac{1}{8}$-in. holes on 7/16-in. centers, is fitted to the journal and the grease is fed through the plate. A spring-loaded follower plate is sometimes used to press the grease firmly against the journal. Where such a device is used, spring pressure should not be sufficient to destroy the grease-block form. Pressure required depends on grease hardness. There should be ample clearance between the grease block and well on all sides, otherwise the block may hang in the well and not make contact with the journal.



Figs. 3*A* and *B*—Screw-piston grease cups adapted to forcing grease through pipes of considerable length

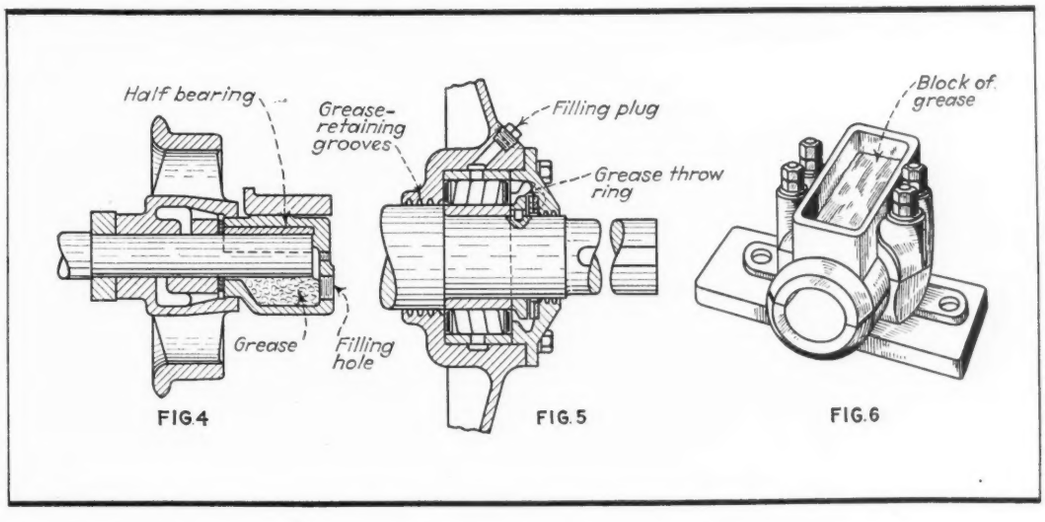


Fig. 4 — Grease-packed bearing on a mine-car wheel. Fig. 5—Grease-packed roller bearing for a synchronous motor

Fig. 6—Bearing provided with a top well for block-grease lubrication

Water Makes It Burn Better

Tempering coal for chain grates is an old story—here's why it works

By Robert H Kuss
MECHANICAL ENGINEER

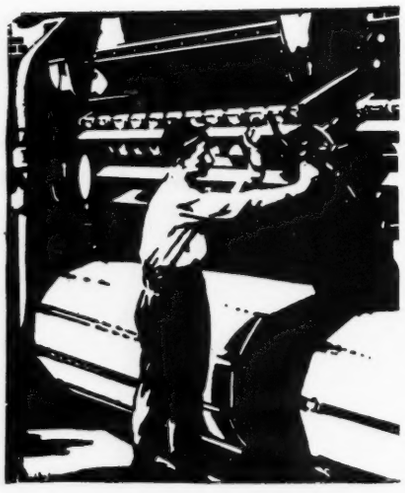
LIKE MANY OTHER special expressions, "tempering" of coal means various things to various people. In the generally accepted sense, tempering is the saturation of every piece of coal in the aggregate, prior to firing. The most common medium for tempering is water, over and above that normally carried by the coal in its natural state. Other liquids are sometimes employed, such as oils and calcium chloride solutions, but these are normally used where tempering is not the primary purpose.

The general reply to the question as to why tempering is resorted to, is "it makes the fire burn better." Such an answer, even if substantially true, supplies no clue or reason as to why or how this effect is obtained. Neither does it indicate how much water is needed for best results or how it should be applied.

Data Lacking

So far as is known no extensive investigations of tempering have been made, consequently the answers to these questions cannot be presented as established facts substantiated by research and controlled experiment. Many furnace-boiler trials have been made, both to test efficiency of the apparatus and to test combustion qualities of various fuels. Such tests, particularly on chain-grate stokers, will usually indicate an improvement in combustion when tempering is employed.

Incidentally, the chain-grate stoker of the natural-draft type is the ideal place to study the effect of tempering, since the fuel bed is divided into zones which represent the successive stages of combustion, and also because the mechanism of combustion on a chain grate is particularly susceptible to conditions which tempering may claim to correct. It is for this latter reason that tempering is most widely used on bituminous coals to be fired on traveling-grate stokers. However, unless successive stages of combustion are carefully analyzed under controlled conditions, it is impossible to determine the exact effect of tempering and to develop reasons for the effect obtained. In view of the lack



of such specific data, it is necessary to depend on observation and deduction from the accepted theory of combustion.

It is generally held that tempering improves combustion by a purely mechanical effect, that is, by promoting the adhesion of fines to coarse pieces. This prevents or reduces sifting through grates and tends to correct size segregation. Other effects of tempering, such as the tendency to reduce caking and the retarding of distillation with possible cutting down of smoke, are not so readily accepted and clearly understood. To obtain these results, the physical and chemical changes which take place in the fuel bed must be altered by the addition of water in quantities considerably in excess of the inherent moisture content. It seems reasonable to believe that such is the case. For example, in certain phases of the combustion process, heat is taken from the furnace, even though the fact that the whole purpose is to achieve a net heat release tends to overshadow this particular point. The presence of excessive quantities of water is bound to effect such phases of the process, increasing the amount of heat taken from the furnace or slowing-up the rate at which the change takes place. Other examples can be readily cited.

In what follows an attempt is made to show the probable effects of tempering at various stages of combustion, and to indicate the benefits which may be expected to result. For the sake of simplicity, the combustion of a single piece of coal will be considered, but it should be remembered that the successive stages described will be taking place simultaneously in the furnace, because a whole succession of such pieces is being burned.

Evaporation of Moisture

As a lump of tempered coal is introduced into the furnace, the initial action is evaporation of the surface moisture. Heat is taken from the furnace to accomplish this change of state, and the evolved steam partly blankets the coal from receiving heat. The effect is to retard volatile distillation at the surface. On the other hand, evolution of steam seems to be violent enough to penetrate the coal and since coal is a poor transmitter of heat, this penetration tends to increase the thickness of the heated outside layer.

Evaporation of the internal moisture follows, and has two effects: it prevents a rise in temperature of the coal greater than that of the steam, and by setting up internal pressure, tends to split the coarser pieces along lines of cleavage. The net result is an increase in the rate of surface burning of the coarse pieces because appreciably more surface has been created. Actual shattering of explosive violence should not be visualized; rather, more generous lanes for steam and volatile gases are created. At this stage, actual penetration of air to the cleavage surfaces can hardly be assumed.

Distillation of Volatiles

While the evaporation of internal steam is increasing exposed surface, the volatiles on the outer surfaces are being distilled and catching fire. The rate of this distillation is retarded by the presence of the steam which is at a lower temperature than that required for distillation and ignition. Extra internal water tends to confine the distillation of volatile matter to the exposed surfaces by preventing the high internal temperatures required for further volatilization. This

slowing-up of distillation promotes a more complete mixture of air and volatiles and a better ratio between the quantities of each present and thus may be said to justify the claim that tempering may reduce smoke.

An important effect of tempering is the reduction of caking. This is also a result of the retarding action of the internal moisture on the distillation process. If heat is applied gradually, the lighter volatiles will be released as soon as the moisture is gone, and will be followed in turn by the heavier hydrocarbons. If the rate of distillation is slow enough, the heavier hydrocarbons will dissociate at a speed equal to the speed of separation from the mass. If the speed of separation exceeds the speed of dissociation, the separated hydrocarbons tend to form a plastic substance known as "ooze." The presence or absence of ooze is of great importance in the ensuing stages of combustion. To understand this, it is necessary to drop the idea of studying the action of a single piece of coal and to consider instead a section of the fuel bed, in which these actions are occurring simultaneously in a large number of pieces.

If distillation of the heavier hydrocarbons takes place rapidly and a plastic tarry substance is formed, the natural effect is coalescence and the formation of a cake, more or less impervious to air flow. Air approach to the remaining fixed carbon is denied and there is failure to burn the hidden fuel. The fuel bed temperature at this point is high enough to break down the heavy tarry substances and these gradually dissociate and burn. Meanwhile the physical circumstances are almost ideal for the formation of coke. Once formed the only recourse is to burn it inwardly from the surface. Even when sufficient air and time are available for this purpose, the result is the creation of wide cracks in the fuel bed and poor air-to-coal ratio.

Excessive Coking

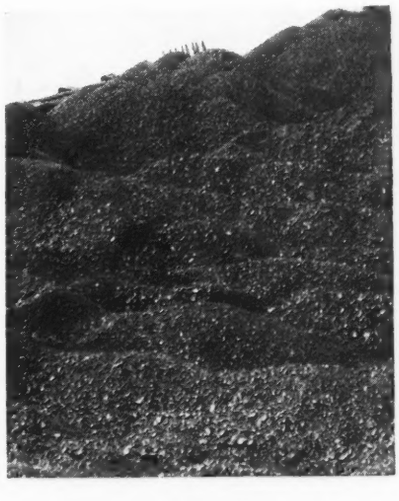
Where excessive coke is made, gradual burning away at the surfaces may form fissures which allow radiant-heat penetration to the bottom of the fuel bed and the refuse residue. Melting of the refuse takes place and air delivery is impeded. A vicious circle is the result of the difficult combustion conditions and the restricted air flow. Lack of air makes for higher furnace temperatures which accentuate the cycle of untoward conditions. Sometimes the ash of the standing coke fuses at the surface of the coke, resulting in glazed nodules which are discharged to the ashpit.

Up to this point, the effect of tempering has been largely to retard combustion, although we have seen that some advantages accrue. When the burning of fixed carbon is considered, it can be seen that the effect is to speed combustion at the most difficult stage of fuel-bed behavior. The prevention of ooze formation, with consequent caking, is thus an important result of tempering.

The effect of tempering on fuel-bed behavior has been considered. What effect does it have on combustion in the furnace space? The slowing-up of distillation already remarked tends to produce a more uniform duty over the entire grate than would be the case if a violent burst of volatile distillation occurred at the start followed by a marked reduction in gas distillation, especially if the last stages are wastefully using air. The whole art of economical combustion, which includes smoke prevention, revolves around uniform gas distillation as a principle of prime importance.

Use on Other Stokers

Reference has been made to the advisability of tempering when firing coal on other types of stokers than traveling grates. An advantageous method of procedure with traveling grates should be correspondingly advantageous with other types, assuming that the same general principles of combustion apply. However, other factors may tend to obscure the gains to be made by tempering. The case of the multiple-retort underfeed stoker is illustrative. Ill effects that might be expected to result from failure to adequately moisten the coal are partially overcome by the compacting features of coal movement, due to mechanical retardation on the lower or discharge portion of the grate. Even then fissures in the fuel bed made by burning-out coke surfaces constitute wide lanes for needless air delivery so that economy is adversely affected. It is believed that tempering would eliminate much of this loss.



Many stoker operators object to tempering coal for underfeed firing on the ground of a difference in coal delivery, between dry and moist coal, under the action of the rams. Wet coal seems to feed away from the ram more than dry coal of the same size aggregate. In some cases this makes for more hopper gas, but on the other hand, surface moisture tends to cut hopper gassing to some extent. In any event, all stokers are adjustable as to place of coal delivery and wet coal is as readily controlled in movement as dry. In my opinion tempering pays with underfeed stokers quite as well as with traveling grates. This remark applies with special force when the coal originates in a dry-shaft mine and has a low inherent moisture content.

Tempering Methods

Assuming that tempering seems desirable in a given case, how is it to be done? Liberal dripping of water into the stoker hopper fails because insufficient time is afforded to admit of moisture penetration prior to entrance into the furnace chamber. Steam in the hopper in place of water accelerates penetration but unless the coal is pre-moistened this method is too slow also. It is recognized that if either method is to be successful wetting for something like 48 hours in advance is necessary. This wetting must be done by spraying small lots, not by soaking in cars or on storage piles.

Inherent Moisture

Coals carrying relatively high inherent moisture receive additional internal water much more readily than other coals. Absorption of water by coals of low inherent-moisture characteristics is slow at the start but becomes more rapid as time elapses. It is this fact that establishes the value of pre-wetting in those instances where final tempering is done at the stoker hopper.

On the basis of the preceding discussion of the value of tempering and the means of accomplishing it, the following conclusions seem to me to be justified: (1) tempering maintains a more uniform size of coal aggregate, (2) it prevents the exudation of tarry ooze, reducing caking and coking, (3) it is of value not only on traveling grates but wherever fuel is fed and moved in the mass, and (4) considerable exposure to water is required for the moisture penetration necessary to adequate tempering.

What Happens

When Water Goes Low

Knowing the answer will help avoid trouble and suggest how to repair the damage if low water does occur

by
Harry M Spring

LOW WATER in a steam boiler is often dangerous and practically always results in damage to the boiler. Responsibility for such a condition lies with the operating personnel, who should know just what happens when water goes low, how to tell when a low water condition has occurred, and how to place a boiler in safe operating condition after minor damage from low water.

Lowest safe water level should not be confused with the lowest visible limit for gage glasses. This point should always be at least 2 in. above lowest safe water level.

Combustion rates and resulting gas temperatures determine the severity of damage from low water. It will be assumed in this discussion that the combustion rate is 150% of rating.

Lowest safe water level for HRT boilers, Fig. 1, and various modified types such as the Lyons combination boiler and the Economic, is 1 in. above the highest part of the top tube row. When the level drops, exposed tubes undergo a sudden increase in temperature. Expansion causes rolled tube ends to break their seats in the rear sheet, and excessive leakage starts immediately. This action continues progressively until the fire is extinguished.

Shell plates, heads, braces, and riveted seams may also be affected. If water goes below the "closing-in line" (the masonry seal between the sidewalls and shell) shell plates become overheated. Tensile strength and yield point drop rapidly, and if load due to internal pressure remains, the shell tends to elongate and bulge. Even slight distortion may start leakage at rivet seams.

Overheating may bow and distort tubes and braces with possible failure of the shell as a result. Leakage from tube ends and riveted seams will usually give warning before an explosion, unless the shell has been weakened by other factors. A fusible plug installed in the rear tube sheet at least 2 in. above the top tube row, will serve as an indicator of overheating.

It is customary to reroll leaky tube ends provided they are not materially distorted or burned. Rivet seams may be made tight by recaulking if the shell plates and butt straps have not bulged or cracked. Extensive repairs to bulged or cracked shell plates should not be attempted except under direction of an authorized boiler inspector.

Horizontal Internally-Fired Boilers

For Scotch Marine (Fig. 2), Scotch Dryback, Locomotive (Fig. 3), Duplex and other internally-fired boilers, the lowest safe water level is 1 in. above the crown sheet or combustion chamber top. In these boilers, low water is exceptionally dangerous, as overheating usually burns off the riveted stay heads which ordinarily support the crown sheet. An explosion usually results.

Examination of the fusible plug, if one is provided in its proper location (the highest part of the crown sheet, extending at least 1 in. above), is the first step in determining whether low water has occurred. Bulging and distortion of the crown sheet are not a sure indication of a past low-water condition, as accumulation of oil, grease, scale, or other deposits may also cause overheating and bulging. In practically all cases where crown-sheet distortion is caused by deposits, a trace of them can be found on other internal boiler surfaces.

Internally-fired boilers without wet-top combustion chambers, such as the Duplex or Scotch Dryback, are affected by low water much as are HRT boilers, with the exception that extreme low levels may bare the internal furnace, and bulging or even rupture may result.

Repairs to distorted crown sheets and bulged furnaces are not often advisable, and renewal is nearly always necessary. In some cases, an experienced boilermaker can heat and drive back a small bulge and install new crown bolts. Leaking riveted seams may be caulked.

Straight-Tube Boilers

Lowest allowable water level for cross-drum (Fig. 4) and longitudinal-drum (Fig. 5) boilers having straight tubes expanded into sectional or box headers, is 6 in. above the bottom of the drum.

First results of low water in these boilers depend on the heat absorbing power of the tubes between the bottom of the furnace and the bottom of the drum. The temperature of gas in contact with the bottom of longitudinal drums on boilers with tubes heavily coated with soot or scale will be abnormally high.

Overheating in the lower, front part of the drum may result in a serious distortion and leakage of riveted seams. As water level goes lower, gas temperature against the drum goes higher. As in the case of firetube boilers, the upper rows of tubes are first affected. Expansion of the tube breaks the seat in the header, causing excessive leakage. This action progresses as the water level lowers. In

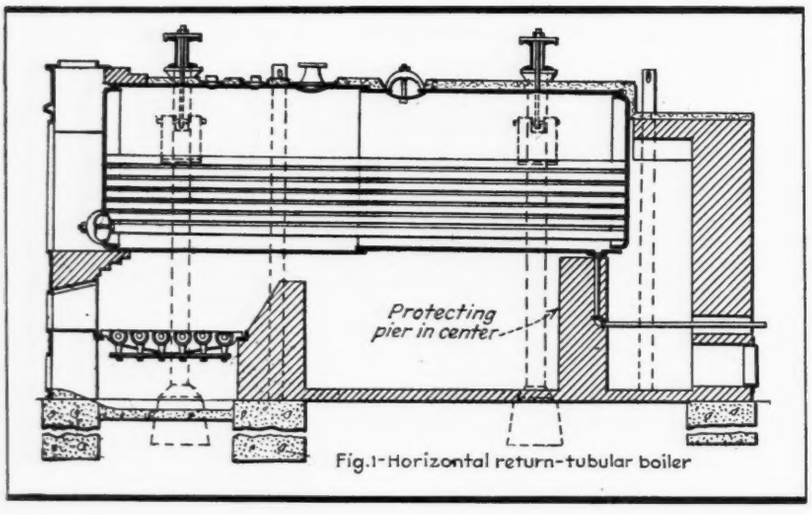


Fig. 1-Horizontal return-tubular boiler

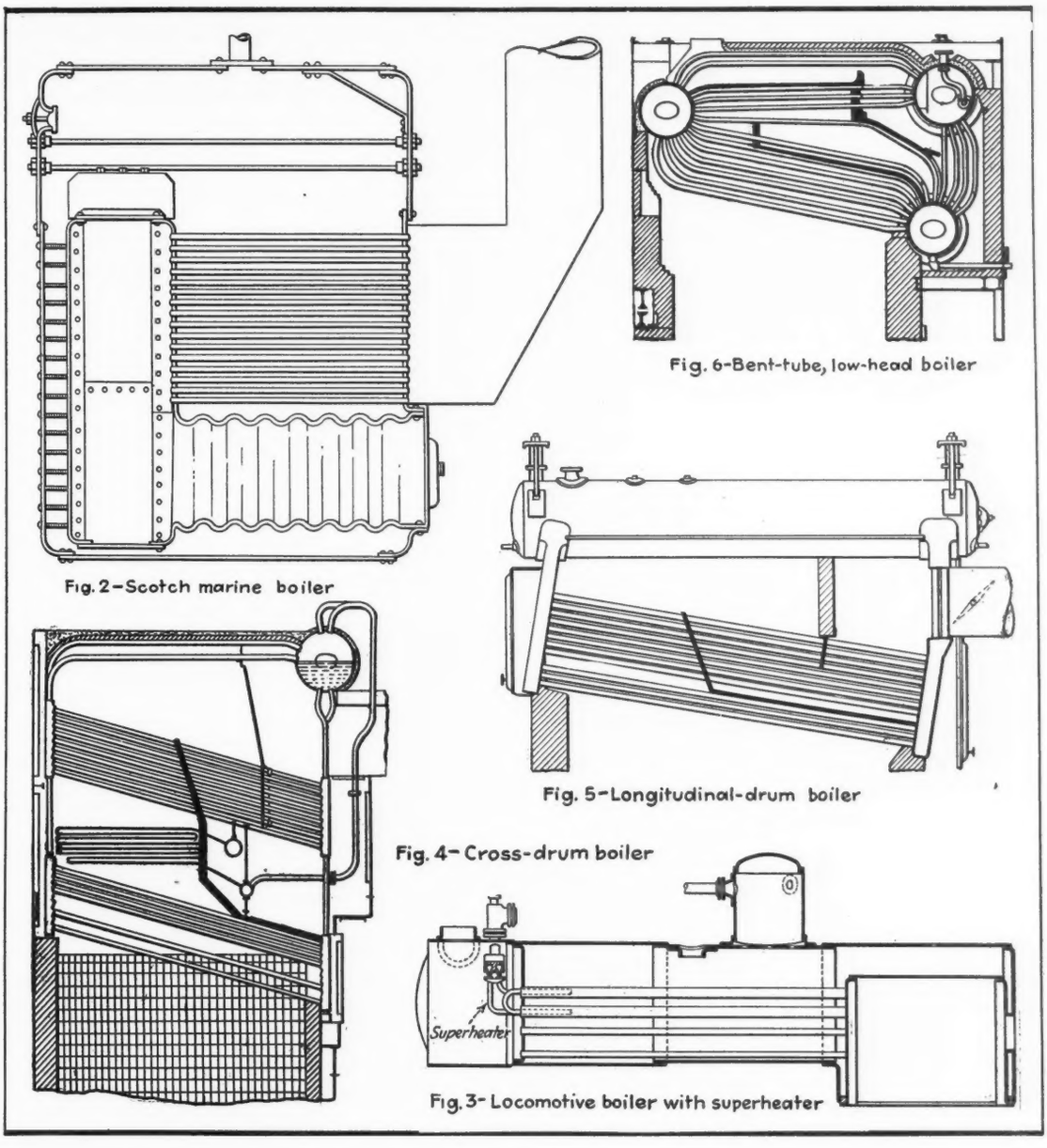


Fig. 2–Scotch marine boiler

Fig. 6-Bent-tube, low-head boiler

Fig. 5–Longitudinal-drum boiler

Fig. 4– Cross-drum boiler

Fig. 3– Locomotive boiler with superheater

boilers with water-box headers, distortion of the tube sheets may cause stretching or shearing of staybolt threads and leakage will result at these points. Severe bowing upwards of the tubes often results from bad overheating, in some cases they may rupture or pull from the tube hole. Lower rows of tubes are affected only if the boiler is practically empty. This is the opposite of what happens when overheating is caused by scale or oil deposits.

It is usually unnecessary to replace slightly bowed tubes, provided the tube ends have not pulled from the seats. Tube ends should project at least $\frac{1}{4}$ in. for flaring to $\frac{1}{8}$ in. Leakage around staybolt threads in box-header tube sheets may be cured by caulking the edge of the staybolt if the tube sheet is not distorted and the staybolt is sound. Major repairs to a leaking riveted seam or distorted drum should be directed by an authorized boiler inspector.

Bent-Tube Boilers

The bent-tube design is so flexible that there are an almost innumerable number of types. A common type is shown in Fig. 6. Lowest permissible water level for bent-tube boilers is 4 in. above the bottom of the front steam drums exposed to the primary combustion chamber, if all the steam drums so exposed are at the same height. If more than one steam drum is exposed to the primary combustion chamber and the drums are not at the same height, the lowest allowable water level will be 4 in. above the bottom of the highest exposed drum. One exception to this rule is the Stirling superheater boiler, in which the lowest water level should be 6 in. above the bottom of the front steam drum. Other exceptions are boilers with isolated or dry steam drums which are not usually exposed to the primary combustion chamber.

The tube bends characteristic of this type of boiler serve to absorb some of the expansion forces set up by low-water conditions. Severe overheating will cause the tubes to break their seats in the drum and may distort the drums. The fact that rows of tubes nearest the fire are affected first in the bent-tube boiler marks the principal difference from the straight-tube type. In general, the suggestions for repairing straight-tube boilers will apply equally to bent-tube units.

Serious damage may have been caused to a boiler as a result of overheating without being readily apparent to the operating personnel. A qualified inspector should examine the boiler before repairs are started or before returning a boiler to service after outage.

Fig. 1—Gas-actuated dial thermometer with long capillary. Note the uniform scale and large bulb

Gas-Actuated
Dial Thermometers

The gas-actuated type is the third member of the dial-thermometer family. This article describes construction, characteristics and applications. The first two members of the family were introduced in September and October Power

GAS-ACTUATED dial thermometers are similar to mercury and vapor-pressure types, in that system pressure changes as bulb temperature changes. The system comprises the usual hollow bulb connected to a bourdon spring by capillary tubing, Fig. 1, and filled with an inert gas, usually nitrogen. Its name is derived from the gas filling, but the thermometer is pressure-actuated in that the increase in gas pressure expands the bourdon spring. The meaning of the name is well understood, however, and is as much a type designation as "mercury" or "vapor-pressure".

Operation is in accordance with the well-known gas law: If the volume of a gas is held constant, the pressure will increase if the temperature of all or any part is increased. Thus, as the temperature of the bulb is changed, the resultant change in pressure causes the bourdon spring to deflect. This motion is transmitted to the pointer by means of a conventional gage-type movement.

Inherent accuracy of a gas-actuated thermometer is high. In fact, the hydrogen-gas thermometer is accepted as a primary standard in thermometry for temperatures which fall within its scope. But the basic or standard hydrogen-gas thermometer is a laboratory instrument. Inherently, the distant-reading gas thermometer is as accurate as the laboratory hydrogen thermometer, but it is subject to service and instrumental errors which are not present in the laboratory instrument.

If all the gas were contained in the bulb, that is, if the line and spring had no volume, pressure in the system would be directly proportional to absolute temperature, in accordance with the law, $\frac{P_2}{P_1} = \frac{T_2}{T_1}$. Or, if the entire system of bulb, line and bourdon spring were heated to the same temperature, this relation would still hold, as indicated in Fig. 2. The system, however, comprises two individual volumes: the bulb to which heat is applied, and the line and bourdon spring which serves to transmit pressure generated in the bulb. Usually, the bulb only is heated, therefore some gas must expand into the line and spring, making the final pressure slightly less because of their volume, Fig. 3. One major requirement of a well-designed gas thermometer is to make the ratio of line and spring volume to that of the bulb small, and within predetermined limits, as indicated in Fig. 4.

By E H Hammond
CHIEF ENGINEER
AMERICAN S & B INSTRUMENT DIV
MANNING, MAXWELL & MOORE, INC

Line Error

Just as in the mercury-filled thermometer, the capillary and bourdon spring acts as an auxiliary bulb, and as such will introduce a line error for changes in line temperature. This error for a gas-actuated thermometer will vary as the square of the absolute bulb temperature. Fortunately, line error for most installations can be kept well within permissible limits

merely by rolling the bourdon spring flat to keep its volume small, by using a fine-bore capillary and a large volume bulb. If it is necessary to use a large-volume spring, then it should be separately compensated by a bimetallic spring, or equivalent means, to reduce the so-called instrument-case error.

For long lines, or large temperature changes along the line, the error can be reduced, but never fully compensated, by using a second system comprising a fluid-filled spring and line without bulb. Operating and compensating capillaries are the same length, and encased in the same armor. The bourdon springs connect to the pointer through a differential linkage in such a manner that movement of the compensating spring subtracts from the movement of the operating spring. The operating spring indicates true bulb temperature plus line error, while the compensating spring tends to subtract the line error. Line error is a function of the square of bulb temperature. Therefore, the method just described does not fully compensate line error, except at one bulb temperature, but it reduces large errors to permissible limits.

This type of compensation, when applied to a mercury-filled instrument, completely compensates for line errors, because in a mercury-filled system line error is a function of line temperature only.

Uniform Scale

In general, it may be stated that a distant-reading gas thermometer will have a uniform scale, Fig. 1; that is, a given temperature increase will cause equal pointer travel at any part of the range. This would not be true, however, if the line and spring volume were large in respect to the bulb volume.

Power available for actuation of a dial thermometer may be measured by the amount the system pressure changes for a change in bulb temperature corresponding to the full dial range. In a gas system, this pressure increase per unit temperature increase depends on several factors such as initial temperature of the range, length of the range, and initial filling pressure. The latter is the pressure in the system when the entire system is sealed at room temperature. It can be shown mathematically that the shorter the range and the higher the initial temperature of the range, the less power will be available.

In any comparison of "inherent" or actuating power, it is only fair to recognize that the gas thermometer can be penalized by a short range and high initial temperature. It can be fairly said that for most ranges the gas thermometer will have somewhat less power than a vapor-pressure type, and considerably less than a mercury-actuated thermometer.

Filling Pressure

It might seem that the initial filling pressure could be selected at will, which is not true. Filling pressure is a very definite function of temperature range, initial temperature, deflection rate of the bourdon spring, filling temperature, and ratio of line and spring volume to bulb volume. If these five factors are known or assumed, the initial filling pressure can be accurately calculated. For any particular range, the manufacturer must select the deflection rate or pressure range of the bourdon spring to give the least possible overload consistent with other design factors.

The gas filling has no appreciable weight, consequently a gas-actuated dial thermometer is not subject to bulb-elevation errors, and the bulb can be installed at any height either above or below the instrument case without error or without having to make a pointer correction for elevation.

A gas thermometer is free of bulb-and-line temperature reversal errors, and will read correctly even though the line and bulb are at the same temperature. Also, a well-designed commercial instrument will have no appreciable error from changes in barometric pressure or altitude.

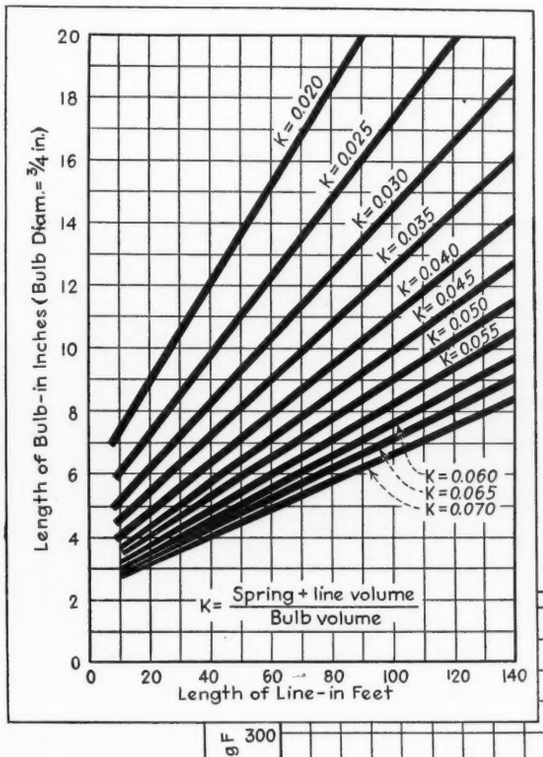

Length of Bulb - in Inches (Bulb Diam. = 3/4 in.)
Length of Line - in Feet
K = 0.020
K = 0.025
K = 0.030
K = 0.035
K = 0.040
K = 0.045
K = 0.050
K = 0.055
K = 0.060
K = 0.065
K = 0.070
K = Spring + line volume / Bulb volume

Fig. 4—Minimum thermometer - bulb lengths for various values of spring, line and bulb volume

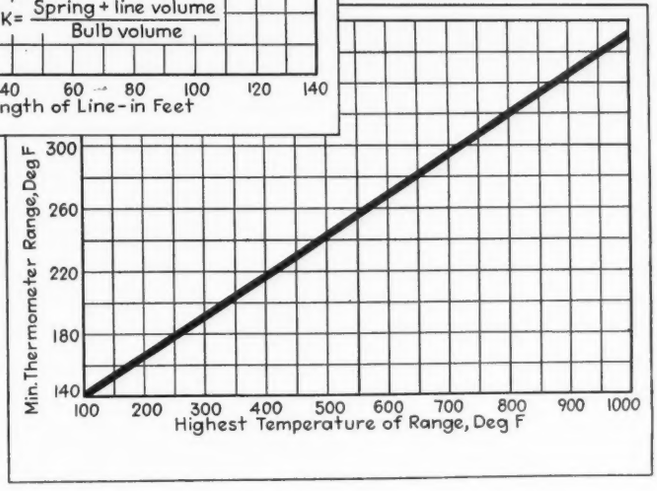
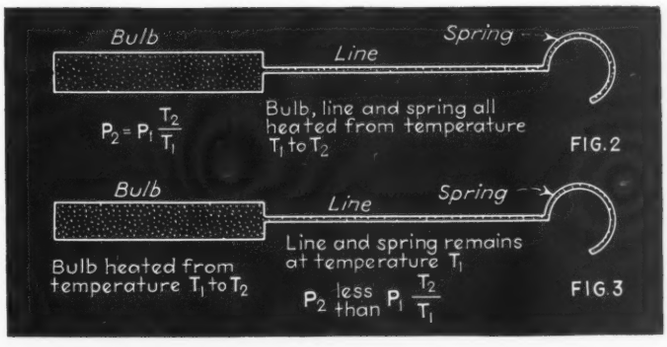


Fig. 5—Minimum length of dial-scale range for different working temperatures

Figs. 2 and 3—Effects of heating bulb only as compared with heating the entire system of gas-actuated thermometer



Averaging Effect

The bulb of a gas thermometer can be made almost any desired length, and therefore is often used to "average" the temperatures in furnaces or flues. Actually, a gas-filled thermometer will not indicate the true average, as will a mercury-filled thermometer. However, if temperature differences along the bulb are not too great, readings will closely approximate the average. Where it is desired to obtain an average of two temperatures at points some distance apart, two bulbs are sometimes connected by capillaries to the same bourdon spring. If the bulbs are the same size, the thermometer will indicate a temperature somewhat lower than the true average. This 2-bulb method should not be used if there is much difference between the two temperatures.

Because it is filled with an inert gas, this type of thermometer can be used for lower temperatures than mercury, which freezes at minus 40 F. Low-temperature thermometers must have a range sufficiently long to insure that the bourdon spring will not be overstressed at normal temperatures during shipment, handling and installation. Manufacturers usually limit minimum temperature to minus 50 or 60 F. Lower temperatures are theoretically possible, but are difficult to calibrate. If the entire instrument is to be subjected to low temperatures, compensation must be made for changes in the modulus of elasticity of the bourdon spring.

The upper range limit is determined by the limitations of bulb material, such as creep, porosity, strength, etc., at high temperatures. Any change in volume of the bulb due to creep or set or loss of gas due to porosity reduces the pressure in the system, and causes an error throughout the range. The upper temperature limit generally is held to 1,100 F or less, as in Fig. 5.

Response

Response in a thermometer is the speed with which it reacts to a change in bulb temperature, and is the opposite of the much-discussed "thermometer lag." The amount of lag is influenced by size and shape of bulb, length of line, size of capillary bore, and by the fluid which surrounds the bulb. Lag will be much greater if the bulb is in air, gas or superheated steam than if it is in a liquid or saturated vapor. It can be greatly reduced by agitation of the fluid surrounding the bulb. Because of larger-diameter bulbs, compressibility of the gas, and lower heat-absorption rate, gas thermometers are somewhat slower in response than mercury or vapor-pressure types.

The lower inherent operating power requires that the pointer and the moving parts of the indicating mechanism of a gas thermometer be light and well balanced, and all bearings be designed to have as little friction as possible. Finally, ruggedness of the system will depend on the stiffness and power of the bourdon spring, which in turn must be designed to meet the ratio of initial pressure to working pressure required to produce full pointer movement. Thus, ruggedness depends on width and initial temperature of the range. For most of the shorter ranges, the gas thermometer will be somewhat less rugged than a vapor-pressure, and considerably less than a mercury-actuated type.

How Much Blowdown?

AT A RECENT conference in London, the question was asked, "What is the proper degree of boiler water concentration when blowdown should take place?" The following answer appeared in *The Betz Indicator,* (September, 1937):

Before arriving at a conclusive answer, it is first necessary to ask ourselves another question, namely, "Why do we blow down a boiler?"

Each gallon of feedwater which enters a boiler contains a specified quantity of solids. These solids are either in solution or in suspension. When the water is evaporated into steam, the solids which were originally present remain in the boiler and the steam which is taken off is supposedly pure water vapor. As each gallon is evaporated from the boiler, another gallon takes its place, and as a consequence, the solids which were originally present gradually build up and concentrate.

As a further example let us assume that we are operating a boiler which holds exactly 1,000 gal. of water and let us further assume that we have total solids present in our feedwater to the extent of 20 ppm. When we first fill the boiler with water, we have 1,000 gal. of water which contain 20 ppm of solids. As this 1,000 gal. is evaporated into steam and another 1,000 gal. is gradually added to take its place, we then have a concentration in our boiler water of 40 ppm of solids. This continues until solids have reached a much higher concentration in the water than were originally present in the feedwater.

As these concentrations gradually build up, they begin to raise the boiling point of the water, affect the surface tension and produce difficulties such as carryover and wet steam. It then becomes essential that a certain portion of the boiler water be removed and replaced with fresh water at a lower solids content, thus reducing the total solids.

As a further illustration, let us assume that we have operated our theoretical boiler until we have evaporated 19,000 gal. of water into steam. After doing this, the 1,000 gal. that still remain in the boiler will contain 20 times the original concentration of the feedwater (which was 20 ppm solids) or contain 400 ppm solids. Suppose we now remove 100 gal. of the boiler water by blowing down, and replace this with 100 gal. of feedwater. Our boiler will then contain 900 gal. of water containing 400 ppm solids and 100 gal. of water containing 20 ppm solids. Concentrations have thus been reduced from 400 ppm solids to 362 ppm (90% of 400 or 360 plus 10% of 20 or 2, a total of 362).

The main difficulty encountered through high concentrations in boiler water is the phenomenon known as carryover, but this in turn can be affected by other conditions. The design of the boiler, the percentage of rating at which the boiler is operated and the chemical and physical characteristics of the boiler water—each have a bearing on the amount of carryover or entrainment of solids to be encountered.

It is therefore plainly evident that the design of the boiler itself plays a very important part in the amount of allowable concentrations that can be carried in a boiler water. Because of the fact that designs of boilers, pressures, percentages of rating, and chemical and physical characteristics of the boiler water vary so much, it is therefore physically impossible to state just how high concentrations in boilers can be allowed before it becomes necessary to blow down.

The figure that is generally accepted as a fair concentration to be carried is 2,500 ppm of total solids in the boiler water, but as actual allowable concentrations will vary in each individual case, the only way to arrive at a successful estimate is to determine by test just what concentration of solids may be permitted.

If You Are Heating a Hotel—

Remember 0.97

Study of 40 hotels shows average figure of 0.97 lb of heating steam consumed per degree-day per 1,000 cu ft

By Charles I Sayles

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HOW MUCH STEAM does it take to heat a hotel? It all depends of course, on local conditions, the number of rooms, percentage occupancy, cubic footage, outside temperature and other things less tangible. Of these, the most important are cubic footage and outside temperature. If you know these two and nothing else you can make a very good guess at the heating steam consumption.

If the hotel is "typical," this is more than a hunch; I have analyzed and compared steam-heating data for 40 hotels ranging in size from 60 to 2,300 rooms (average 640), from Ontario to balmy Tennessee. The average of the whole lot is 0.97 lb of space-heating steam per deg-day per 1,000 cu ft. Even more significant—very few of the hotels depart far from the average. I therefore offer it as a constant which will help operating engineers, hotel operators, public utility engineers and designing engineers in preliminary estimates and comparisons.

Of course, few hotels have meters to measure the total steam; even fewer meter separately requirements for hot water, space heating, laundry and kitchen. Most hotels even guess, rather than measure, the water evaporated per lb of coal fired.

Typical hotel laundries use steam at 90 lb g, kitchens at 40 lb. Rooms and hot water are heated by low-pressure steam. In this article the expression "service-steam requirements," does not include steam used to generate power. It means, rather, the total of service steam for space heating, laundry, hot water and kitchen.

Fig. 1 shows the questionnaire that was filled out by 40 hotels. Some reports were incomplete; graphs and tables include only what was supplied. Table I shows some of the data furnished. Of the 40, only four make their own electric power.

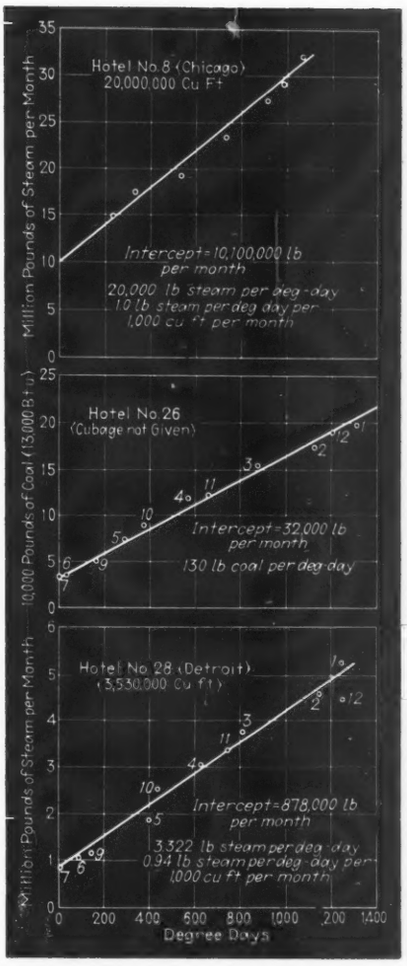

Hotel No 8 (Chicago)
20,000,000 Cu Ft
Intercept=10,100,000 lb per month
20,000 lb steam per deg-day
10 lb steam per deg day per 1,000 cu ft per month
Million Pounds of Steam per Month
Hotel No 26
(Cubage not Given)
Intercept=32,000 lb per month
130 lb coal per deg-day
Thousand Pounds of Coal (13,000 Btu)
Hotel No 28 (Detroit)
(3,530,000 Cu ft)
Intercept=878,000 lb per month
3,322 lb steam per deg-day
0.94 lb steam per deg-day per 1,000 cu ft per month
Million Pounds of Steam per Month
Degree Days

Fig. 2—Steam (or coal) plotted against deg-days for three typical hotels

Fig. 1—Questionnaire submitted to hotels

STEAM CONSUMPTION

Year (1935) _____ Hotel _____ No Rooms _____

City _____ Cubage _____

NOTE It is not expected that any one hotel can supply figures for all columns. Many can answer only Columns 1 and 4. In some cases Column 4 can be answered in terms of "pounds of coal" or "gallons of oil". Any information at all will be appreciated.

1 PER CENT OCCUPANCY	2 Month	3 Degree-Days	4 TOTAL STEAM USED, 1000 Lb	5 Steam for Heating 1000 Lb	6 Steam for Hot Water, 1000 Lb	7 Kitchen Steam 1000 Lb	8 Laundry Steam 1000 Lb	9 Power Steam 1000 Lb	10 Maximum for month, 1000 Lb/Day Total
	PRESSURE								
1	Jan.								
11	Nov.								
12	Dec.								

Additional Information

Boiler pressure _____ Fuel used (coal, pulverized coal, oil, gas) _____
Heat content of fuel in Btu _____
What major units such as generators and refrigeration compressors are steam driven?

_____

_____

If you make your own electricity, do you determine its cost? (yes or No)

Weather Heating Demand

The first step, of course, was to plot total steam consumption against deg-days. This unit, already familiar

Table II
Method of Figuring Degree-Days

	Av. Daily Temp, F	Deg-Days in Given Day
Sun	60	5
Mon	55	10
Tues ..	52	13
Wed ...	57	8
Thurs ..	63	2
Fri	68	—
Sat	60	5
	Week's Total	43

to most readers, measures the heating demand of the weather. Other things being equal, heating steam is needed about in proportion to deg-days. As an example, let's say that the daily average temperatures for a week run as shown in Table II. Deg-days for each day are found (Column 2) by subtracting the average outside temperature from 65 F. The week's total in this case is 43, and the same method can be used to determine the total for a given month, season or year. In most large cities it is possible to get monthly total deg-days directly from a nearby Weather Bureau station.

The plot of total steam against deg-days is generally a fairly straight line, as shown in Fig. 2 for three typical cases. Since the rise of the line represents heating steam, the starting value (at zero deg-days) may be taken as the steam used for laundry, hot water and kitchen. Slope of the line gives heating steam per deg-day, which is then reduced to a basis of 1,000 cu ft. Averaging this figure for the 40 hotels, we get 0.97 lbs of steam per deg-day per 1,000 cu ft.

This constant, however, would have little meaning if many hotels varied widely from the average. Evidently they don't, for in the 40 hotels studied, the "average variation from the average" was only 10%.

Coal burned per deg-day per 1,000 cu ft averaged 0.149 lb. Put 0.97 and and 0.149 together and you get an average evaporation of 6.5 lb of steam per lb of coal.

October Runs High

Readers will note a peculiar thing in many of the curves: October steam generally runs high, for no obvious reason. Perhaps it's a matter of psychology. With summer just fading out of sight, guests feel chilly and demand overheating. Yet the charts show no reversal of this condition for April. Choose your own explanation.

Then too, many hotels use less steam in very cold weather than the curves would lead one to expect. Probably most hotels are overheated and windows opened in all but very cold weather for lack of proper room control, but when the mercury hovers around zero, radiators are none too big and heating-system efficiency actually increases.

As already pointed out, the intercept of the total-steam-consumption curve, that is, the steam consumption for zero deg-days, is taken to be the steam for other service requirements —laundry, hot water and kitchen. One naturally expects space-heating steam to depend upon deg-days and total cubic footage, but the requirements for hot water, laundry and kitchen should depend more nearly on number of rooms and occupancy. Table I gives data of rooms and occupancy. Fig. 3 plots special-service steam against number of rooms, and Fig. 4 against rooms occupied, the latter a more reliable basis. Results here are far less uniform than for heating steam. This perhaps is natural, because the quality of hotel service and type of clientele greatly affect steam demands of laundry, kitchen and hot water. High- and low-limiting lines are drawn to show the range.

Several cases fall far out of line. Sometimes more steam is used for

Fig. 3—Special-service steam (consumption for zero deg-days) plotted against number of rooms. See text for explanation of two lines

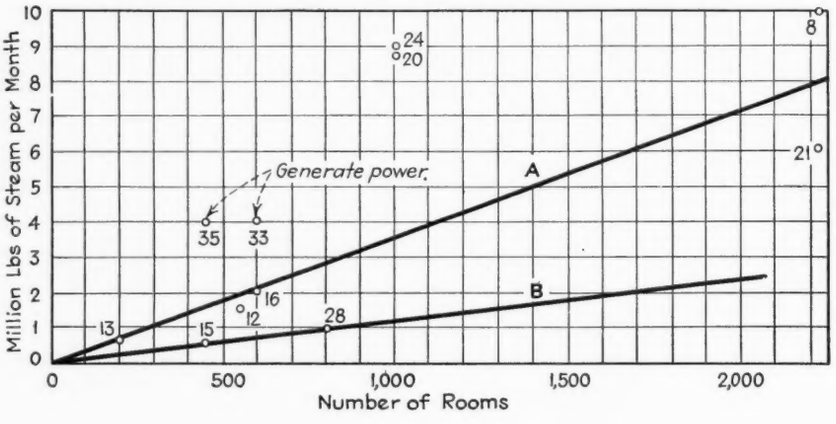


TABLE I—DATA AND RESULTS FOR INDIVIDUAL HOTELS

No.	Cubage	No. Rooms	% Occupancy	Intercept for zero deg-days: Steam 1,000 lb	Intercept for zero deg-days: Coal 1,000 lb	Lb per deg-day: Steam	Lb per deg-day: Coal	Lb per deg-day per 1,000 cu ft: Steam	Lb per deg-day per 1,000 cu ft: Coal
8	20,000,000	2,268	.....	10,100	.....	20,000	.....	1.000	.....
9	374,000	.....	.....	60	.....	345	.....	0.922	.....
10	.....	.....	.....	None	.....	.....	.....	.....	.....
11	.....	.....	.....	None	.....	.....	.....	.....	.....
12	4,000,000(a)	565	58.2	16,000	.....	3,400	.....	(0.850)	.....
13	850,608	200	63	(576)	72	.....	130	.....	0.153
				(976)	122	.....	.....	.....	.....
14	.....	.....	85.4	None	.....	.....	.....	.....	.....
15	1,580,328(b)	450	52.2	460	.....	2,070(c)	.....	(1.310)	.....
16	.....	600	.....	(2,080)	260	.....	.....	.....	.....
17	.....	125	67	.....	36	.....	.....	.....	.....
19	998,000	163	53.8	250	.....	1,020	.....	1.022	.....
20	5,000,000	1000	39.3	9,000	.....	.....	.....	.....	.....
21	20,300,000	2206	55.7	6,000	.....	20,000(d)	.....	0.985	.....
22	1,020,600	.....	.....	.....		Deg-days not available			
23	.....	.....	.....	.....	.....	.....	.....	.....	.....
24	10,078,218(e)	1083(e)	40.6	9,000	.....	8,400	.....	0.972	.....
25				Very bad data					
26	900,000	165	.....	(248)	31	.....	130	.....	0.145
27	.....	.....	.....	.....	.....	.....	.....	.....	.....
28	3,530,000	800	.....	878	.....	3,322	.....	0.943	.....
29	1,695,000	300	.....	227	.....	1,130	.....	(0.668)	.....
30	283,000	200	.....	80	.....	.....	.....	.....	.....
31	11,320,020	100	56.4	40.5	.....	1,050	.....	0.926	.....
32	.....	.....	.....	None		Deg-days not available			
33	.....	.....	.....	.....	.....	.....	.....	.....	.....
34	.....	.....	.....	.....	.....	.....	.....	.....	.....
35	7,750,000	400	.....	4,000	.....	.....	.....	.....	.....
36	.....	.....	.....	21,000	.....	.....	.....	.....	.....
						0.97 average			

(a) Sq ft area provided instead of cubage (b) 368,160 cu ft garage included (c) Estimated from oil and coal burned (d) Consumption very erratic (e) 144,000 cu ft, 323 rooms unused

special services, sometimes much less than average. Generally, there is a satisfactory explanation. Some operate no kitchen; others purchase steam and eliminate boiler-room auxiliaries and losses. In one case, a hotel runs a complete steam plant and supplies neighboring buildings. Another buys steam for operating refrigerating compressors.

To come to some "standard" for general use in rough estimates and comparisons, we say that 4,800 lb of steam per occupied room per month plus 0.97 lb per deg-day per 1,000 cu ft will give a close approximation to the total service steam for a hotel. Here is something new for hotel engineers to think about.

(Editorial Note: A further article by Mr. Sayles will describe the preparation of daily and yearly steam-consumption curves.—Editor.)

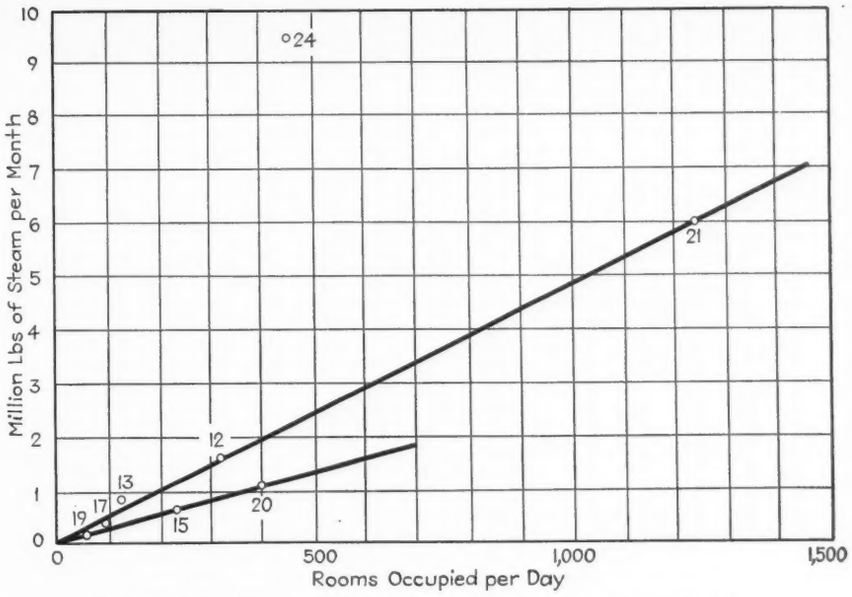


Fig. 4—Special-service steam (consumption for zero deg-days) plotted against average number of guests (rooms x % occupancy)

And Now
A Condensing Top

Superposition turbines are becoming familiar. Here is a new idea—a condensing topping turbine, now under construction

By N D Gove

DESIGN ENGINEER
WESTINGHOUSE ELECTRIC & MFG CO
SOUTH PHILADELPHIA WORKS

SUPERPOSITION, the topping of existing plants by new high-pressure non-condensing units, is playing a leading part in the present advance of the central-station industry. Three large units of this type are in daily service, each capable of handling over a million pounds of steam per hour. The technical press has been full of the theory, practice, and benefits of superposition until it has seemed both to the writer and to the reader that nothing more remained to be said on the subject except to mention new and larger installations. However, while attention has been focused on superposition practice, another principle manifested in the superposition-condensing turbine has been developed and is being rapidly put into practice by the building of the first unit of this type in the Westinghouse shops.

The superposition-condensing principle is a natural evolution of the bleeder turbine supplying steam for process heating. In this new application, however, steam extracted passes to the throttle of a low-pressure unit and continues its expansion just as if it had come originally from the low-pressure boiler system. The high-pressure unit is partly a superposition turbine, while the succeeding stages are typically those of a condensing machine. When steam is not bled for the older unit, the high-pressure unit operates on the normal condensing or regenerative cycle.

Applications

A concrete example of this principle, a turbine now under construction, is rated at 30,000 kw. On the customary regenerative cycle it will operate at steam conditions of 1250 lb, 900 F and 28.5 in. vacuum, with four stages of feedheating. The turbine will develop its rated capacity with a steam supply of about 258,000 lb per hr. At this same rated load, when 430,000 lb per hr is supplied to the throttle, 210,000 lb per hr will be bled at 250 lb. This bled steam will pass into an old 250-lb turbine, replacing steam from low-pressure boilers, and will be condensed in the old condenser. The condensate will rejoin that of the new turbine at the low-pressure heater. This unit will furnish 30,000 kw of high-efficiency condensing power (few condensing turbines in the world will have a better heat rate) or, alternately, can supply a 30,000-kw unit to yield a total of about 50,000 kw of low-heat-rate power. A schematic diagram of the arrangement is shown in Fig. 1.

A second application, recently proposed, plans extracting about 200,000 lb per hr at 400 lb from a 35,000-kw unit into an existing boiler header to supply existing turbines. While the primary purpose is to reduce overload on the present boiler plant, this installation is a profitable rejuvenation of part of the existing capacity.

No Grid Valves

Grid valves or secondary steam chests are not required in the superposition-condensing turbine. Pressure at the extraction point rises with load

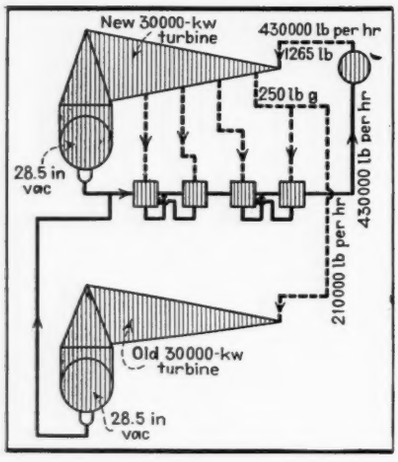


Fig. 1—Schematic diagram of 30,000-kw superposition-condensing unit

so that when a predetermined rating is reached, extraction into the other system can start. As the load is increased further, more steam can be extracted at the same pressure, flow through the lower stages remaining constant. To maintain a given amount of bleed steam, it is only necessary to keep constant load and allow excess steam to spill over into the low-pressure system.

The superposition-condensing turbine may be arranged with existing turbines in several ways. One is to locate the extraction opening so that the two turbines may be operated as a cross-compound unit under sole governor control of the new unit. Load will be divided between the two in a relatively constant proportion, and the only safeguard necessary is to protect the low-pressure turbine by a relief valve in the "crossover line."

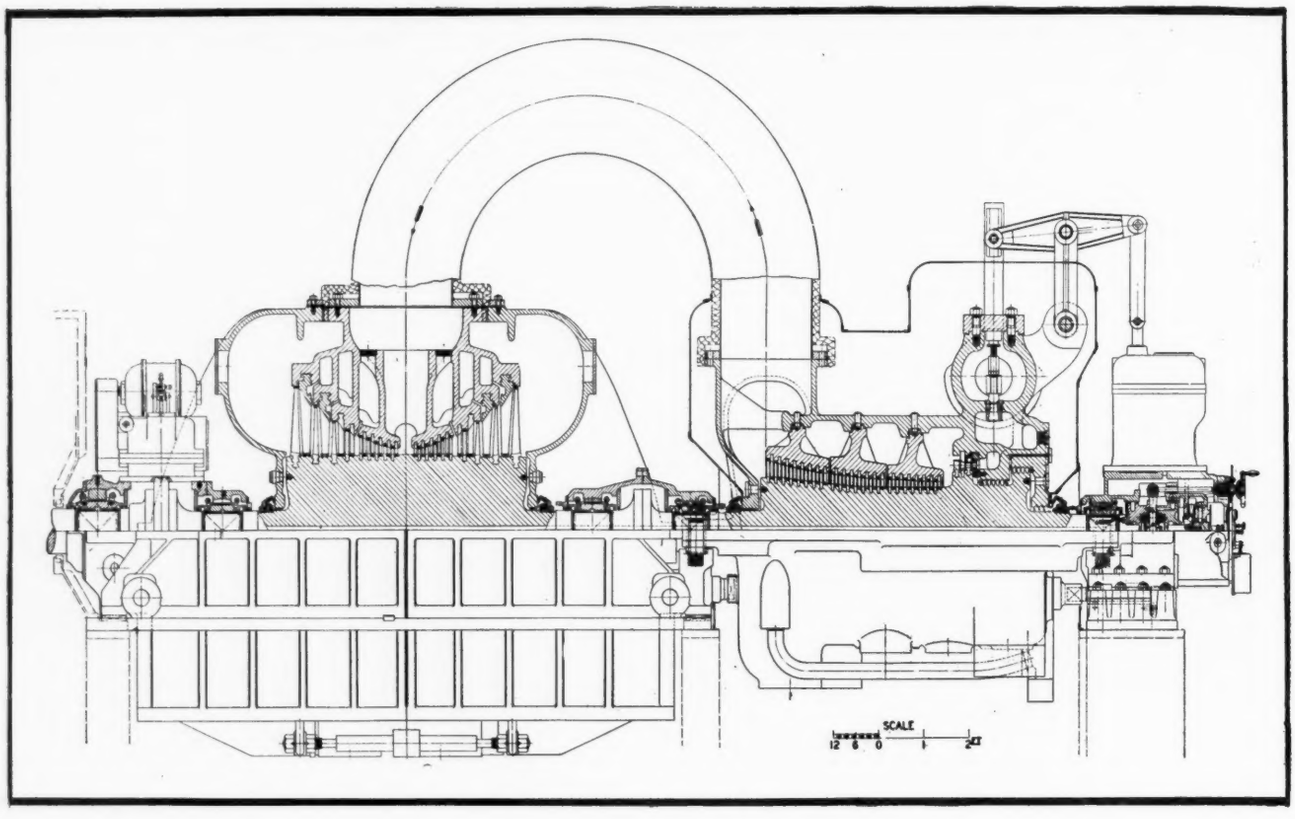
Control

Operation of essential auxiliaries sometimes precludes varying the inlet pressure of the old turbine. In this case, the low-pressure turbine governor is left in service and load on the new turbine adjusted by means of the speed changer until the pressure at the extraction point is built up to the point where steam will flow to the older turbine. This hand control is proposed for the unit now under construction. A partial safeguard is provided by a hand latching device which, when the new turbine is operating alone, can be engaged to prevent governor valves from opening to their full extent and overloading the generator. There is no safeguard in this case except the vigilance of the operators to prevent load being transferred quickly from the old unit to the new in the event that the circuit breakers of the old generator trip out. Protection against this could be obtained by the installation of a load-limiting device, a wattmeter-operated control which works on the speed-changer motor to maintain a predetermined load. With this and pressure protection for the low-pressure turbine, operation can be safe and efficient.

Another type of control giving more nearly automatic regulation, consists of a backpressure regulator to maintain pressure at the extraction point. This regulator will call on the main governor to furnish the right amount of steam to maintain constant extraction pressure, which in turn will result in a constant flow of steam through succeeding stages of the new unit. Load on the new unit will vary only by the changing steam flow through the first stages—say from 85 to 100% of rating. Meanwhile, the major part of the load swing will be taken by the low-pressure turbine operating under control of its own governor at a constant inlet pressure. This device safeguards both units and automatically throws load swings onto the older, and presumably less efficient, unit.

We expect to see extensive adoption of the superposition-condensing principle, since it combines the advantages of superposition with the requirement of new condensing capacity. Whether the new unit is considered as developing a block of low-cost byproduct power or whether the combined units are considered as working together on a modern steam cycle is immaterial, since the gains evaluated either way are great enough to make the proposition attractive.

Fig. 2—Section of a typical 30,000-kw superposition-condensing turbine



Superposed Turbines

Details of operation and control of topping turbines applied in modern plants

By R J Caughey
TURBINE ENGINEERING DEPARTMENT
GENERAL ELECTRIC COMPANY

SUPERPOSED TURBINES fall into two general classes. First are those used in plants where one or more relatively small superposed turbines deliver steam to a low-pressure header and second, relatively large superposed turbines which supply exhaust steam enough for several low-pressure turbines. We distinguish between these arbitrary classes to separate constant backpressure operation from a compound-turbine arrangement. The problem of operating small backpressure turbines of the first class has been satisfactorily met in several existing plants; little experience is available in the control of turbines of the second class.

Starting in both cases is similar, depending only on the valve and piping arrangement. Starting is accomplished in two ways: atmospheric backpressure and full backpressure. Each method has its advantages, and operators have so far shown little preference.

Atmospheric Exhaust Starting

Fig. 1 shows the usual piping and valve arrangement for atmospheric backpressure starting, including an atmospheric connection from the turbine exhaust large enough to pass steam for bringing the turbine to half speed. A gate valve (or optionally a check valve too) isolates the turbine from the low-pressure header during starting. Enough steam is admitted to bring the turbine quickly to about 20% normal speed with water supplied to both high-pressure and low-pressure packings. Speed is then slowly increased to about half normal without exceeding 25 lb g backpressure. Higher backpressure below half speed may cause excessive steam leakage into the station through failure of packings to seal; above half speed they will function satisfactorily.

At half speed, the atmospheric exhaust line valve is slowly closed, building up the backpressure and requiring more steam at the throttle to maintain speed. After the backpressure reaches that of the low-pressure header and the gate or check valve is opened, speed is gradually increased until the governor assumes control.

This method of starting uses very little steam and results in slow and uniform heating of the turbine shell. Steam leakage around packings is small and danger of oil contamination from condensed leakage steam is minimized. Disadvantages are the added cost of the exhaust connection to atmosphere and the inability to recover condensate from the starting steam.

Full Backpressure Starting

For full backpressure starting, the gate valve isolating the superposed turbine is opened first, filling the turbine with steam from the low-pressure header, or, if a check valve is installed in the exhaust connection full backpressure exists throughout the shell almost as soon as the throttle is cracked open. To prevent leakage of steam into the turbine room and contamination of oil by the leaking steam, the packing leak-off lines must be vented to atmosphere or, preferably, to a vacuum.

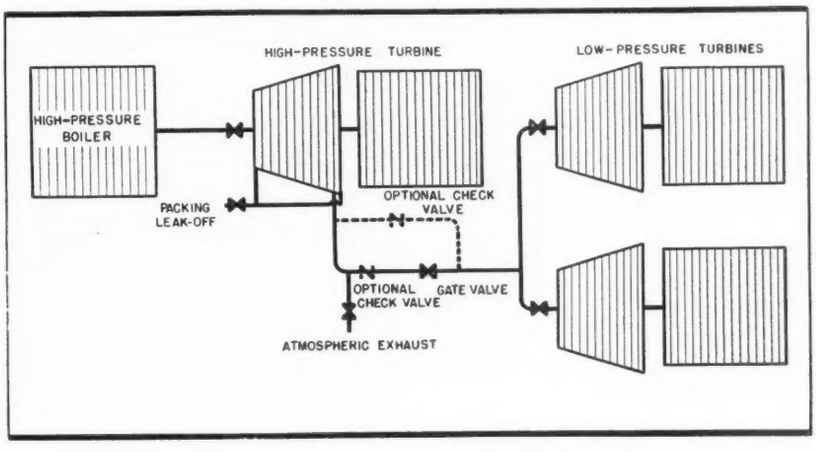
The turbine is brought quickly to half speed, at which point the water packings start to seal, and the procedure is the same from then on as for atmospheric backpressure starting.

Full backpressure starting exhausts no steam to atmosphere and all condensate is recoverable. More starting steam is required and packing leakage is much greater; also the larger steam flow produces quicker and more uneven heating of the shell.

Governing

For superposed turbines of small size compared to the total plant, and particularly when backed up by low-pressure boilers, a quick response to load change may be undesirable. For this case the control system is designed so that the turbine may be run on either speed control or backpressure control but never on both. Connections are provided in the governor linkage so that either control may be selected with the other automatically

Fig. 1—Diagram of piping and valves for atmospheric back-pressure starting



rendered inoperative. The linkage is illustrated in Fig. 2. A broken floating lever connects the speed governor with the hydraulic mechanism; a sliding collar forms the connection between the backpressure regulator and the hydraulic cylinder through the lower half of the broken lever. The operator can shift control from the speed governor to the pressure regulator to change from baseload operation to variable loading under backpressure control.

These two conditions of operation are encountered when superposed turbines exhaust to a header in common with low-pressure boilers. When the high-pressure turbines operate on baseload, variations in steam demand are taken by the low-pressure boilers, the backpressure regulator being set to act only in case of an excessive rise in backpressure. When the low-pressure boilers are banked, the high-pressure turbine can be set to maintain constant exhaust pressure by setting the synchronizing spring to its full-load position and the pressure regulator holding the control valves at about half-load position. The broken floating lever is therefore open and the control valves have no positive connection to the speed governor until it has traveled through half its stroke. The speed governor can, however, close the control valves in emergency even when the pressure regulator calls for full steam flow.

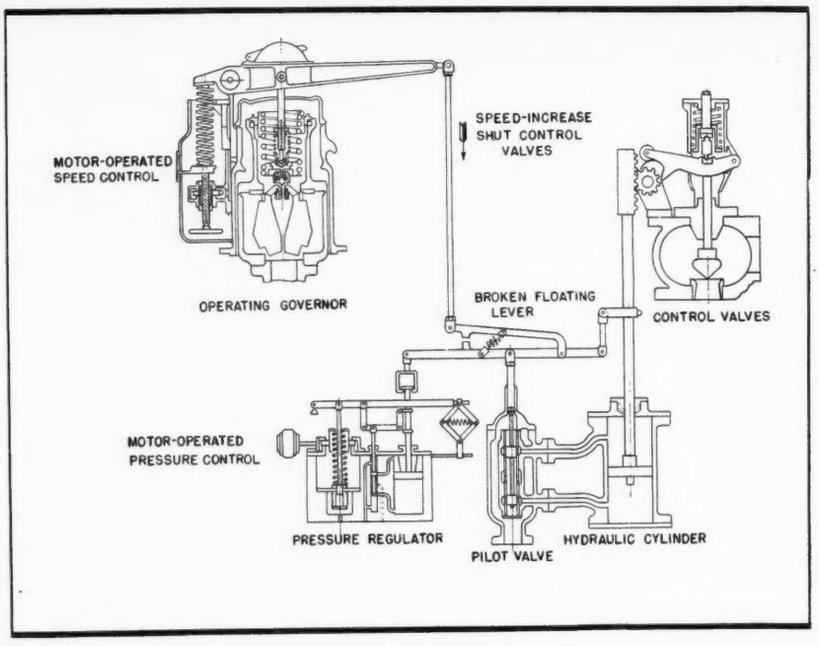


Fig. 2—Control arrangement for either speed or backpressure governing

Regulator

To apply load to the turbine by means of the backpressure regulator after synchronizing, the regulator is first set to pass no-load steam flow. Then the speed governor is set in the full-load position; during this operation the regulator continues to maintain no-load steam flow. Adjustment of the regulator then applies load to the turbine as desired. Thereafter, any change in station load will affect the speed governors of the low-pressure turbines to change steam flow with a consequent change in backpressure on the high-pressure turbine. This in turn will be translated into a movement of the control valves of the high-pressure turbine by the pressure regulator. If, however, the load is lost by opening the generator switch of the high-pressure turbine, the turbine will overspeed enough to cause the speed governor to close the control valves. In this event, the low-pressure turbines will also drop load unless supplied through a bypass reducing valve or from low-pressure boilers.

When the superposed turbine represents a large proportion of the station capacity, the governing problem is somewhat different and should be considered more like compound-turbine operation. A difference exists, however, from what is ordinarily considered compound-turbine operation in that receiver (exhaust) pressure is held constant.

For this case, the primary control should be the speed governor responding to changes in total station load. This condition would be easily met if the high-pressure and low-pressure governing mechanisms had exactly the same characteristics, a condition which is practically impossible. There will also be a time lag due to the volume of steam entrained between the high-pressure turbine exhaust and the low-pressure control valves.

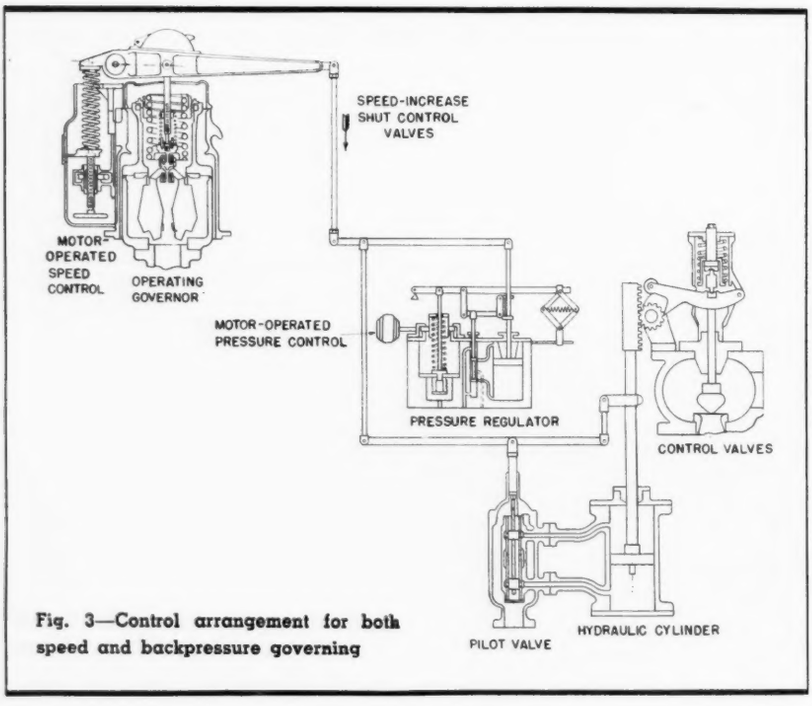


Fig. 3—Control arrangement for both speed and backpressure governing

Response to Control

Attempting to operate a number of turbines in the above manner would result in a variation in backpressure with station load. If, however, the high-pressure turbine is subjected to both speed and backpressure control, the steam flow can be slowly adjusted to proper quantities. A typical arrangement for such a control mechanism is shown in Fig. 3. Response to both speed and backpressure is accomplished by connecting the speed

governor and the backpressure regulator to the hydraulic mechanism for operating the control valves in such a way that either is free to operate the control valves at any time. The response to speed change is made as fast as necessary for overspeed control but the response to backpressure change is made slow. Then, in normal operation, the station load is changed by resetting the low-pressure governor only; change in high-pressure turbine output will result from the consequent change in backpressure. The speed governor must then be reset to take over control of the high-pressure turbine valve operation.

When a sudden and involuntary change in load is required by system conditions, the control valves of both high- and low-pressure turbines react simultaneously and the backpressure regulator is only called upon to readjust the steam flow to the high-pressure turbine after the load changes have occurred. During this operation, the backpressure governor first forms a pivot about which the governor moves the pilot valve; later the speed governor becomes a pivot point for the pressure regulator.

Speed Governor Movement

As long as the backpressure control system remains fixed, the whole mechanism functions as a standard governing system responsive to speed changes. When a movement of the speed governor results in a change in backpressure, the consequent motion of the operating piston of the backpressure regulator fixes a new point about which the speed governor pivots. The speed governor is continually floating and in position to respond quickly to a speed increase if the high-pressure-turbine generator becomes disconnected from the line. In this event, the speed governor will close the control valves and reduce steam flow and back-pressure, which in turn will result in a movement of the pressure-regulator piston in a direction to open the control valves. Because of the lever proportions, the control valves will remain open an amount sufficient to operate the turbine about 3% overspeed and pass no-load flow into the low-pressure system.

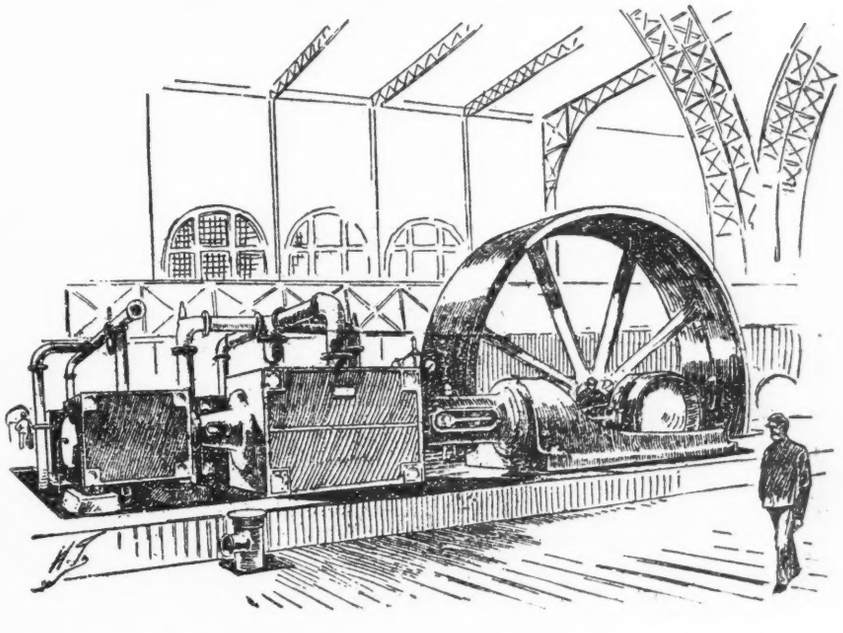
Where the superposed unit is a large proportion of the station capacity, the loss of its output and the simultaneous loss of low-pressure-turbine capacity represented by the exhaust steam supply may result in too great a reduction in system capacity. To reduce this loss to the high-pressure unit capacity only, an automatic bypass valve and desuperheating arrangement may be provided. The bypass valve must open very rapidly to prevent serious loss of load and subsequent sudden recovery. The valve should open within the time it takes the control valves of the high-pressure turbine to close.

The World's Fair Steam Giant

OLD TIMERS will remember the 3000-hp Corliss engine in the Machinery Hall at the Chicago World's Fair in 1893, smaller and "dumpier" than the 1200-hp Centennial Corliss of 1876. A clipping, just come to life from the old Chicago *Sun,* dated April 23, 1893, may pass on a few smiles. Headlines are: "First Sip of Steam—Monster Engine Given a Test—Hot Breath of Life Throbs in the Mighty Cylinders of the Giant that is the Pride of the World's Fair Machinery Hall". The following quotations are picked at random: "The '$80,000 beauty,' as it is familiarly called, will furnish the power for two Westinghouse incandescent light machines, each of 10,000 lights! That is all. In the minds of men familiar with the working of engines, however, this is considered quite enough. Indeed many of them are loath to believe that it is possible for any one engine to perform the gigantic feat. . . . The monster is known as a Reynolds-Corliss quadruple-expansion engine. Its whole weight is 325 tons. Many of the gears were especially constructed for it. The cylinders are four in number and arranged tandem. The sizes of the cylinders are as follows: 26 by 72, 40 by 72, 60 by 72, and 70 by 72. The first of these weighs ten tons, the second eighteen tons, the third twenty-three tons and the fourth thirty tons. The pressure of steam will be about 115 pounds to the inch. The flywheel is 30 feet in diameter, while its face is 76 inches broad. It will carry the largest belt in the exposition. This mighty wheel is built of twelve sections, each weighing 8,000 pounds. It has twelve arms, each weighing 2,100 pounds. The shaft on which it rests is a piece of steel 17 feet long and 21 inches in diameter. The great shaft weighs 35 tons. Every second the mighty wheel will make a revolution . . ."

The engine was started by no less a person than President Cleveland himself. Says the article, "when the President puts his finger on the electric button, a four-inch bypass in the big cylinder will be thrown open, the steam will rush in and the ponderous wheel will slowly revolve. It is all very simple."

A reproduction of the *Sun* drawing of the big horizontal engine at the Chicago World's Fair in 1863



Speaking of POWER . .

PHIL SWAIN . . . . . Editor

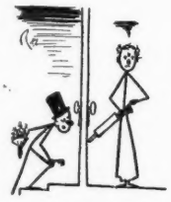
IN YEARS GONE BY, Fred Low, grand old man of *Power*, often found occasion to attack the claims made for so-called "fuel savers" and "smoke eliminators". These led him into some rather nasty fights, from which he invariably emerged victorious . . . I find an example in *Power* just twenty-five years ago. Blast and counterblast filled a page of the number of Nov. 8, 1912. According to the manufacturer, you dissolved 8 lb of his nostrum in 8 gal. of water, sprinkled it on a ton of coal in the yard and, presto, smoke disappeared and fuel bills fell 20 to 30% . . . Fred Low disputed these claims in no uncertain terms. The maker demanded a "repudiation." Low obliged with a published offer to post bond, pay all costs of a test by impartial engineers and then publicly apologize *if* the tests confirmed the claims. His offer was never accepted . . . Now, a quarter century later, additional proof of Fred's judgment is placed on the record by my good friend P. Nichols of the Bureau of Mines. His paper at the October fuels meeting in Pittsburgh reports extensive tests with a variety of chemical solutions sprinkled on various coals in various quantities. The net conclusion is that there's nothing in it—hardly any measurable results one way or another, except, under certain conditions, a little benefit *from the water*.

. . . presto, no smoke

Every now and then I hear of some chief engineer who seems deathly afraid to have his subordinates learn much about his own job, or get credit with the management for their own contributions to successful operation. Such an attitude strikes me as mighty small and also a sure indication that the boss lacks confidence in his own knowledge and ability. . . . Abraham Lincoln said, "You can't fool all of the people all of the time". Subordinates eventually see through a chief of this sort. He may scare them, but he can't bluff them. And he isn't earning the loyal cooperation which will be so terribly important to him in an emergency . . . There is only one sensible course open to the assistant engineer or shift engineer who finds himself under a man of this type. Let him serve his boss loyally and intelligently. Let him have no part in the gossip that takes place behind the chief's back, even though the things said be only too true. And let him meantime keep his eye out for another job under a chief who has enough common sense and sportsmanship to encourage ambition and reward merit.

. . . can't fool all

We've been doing a lot of talking about high steam pressures in industrial plants, but I hope we haven't given the impression that it would pay the average industrial plant to go to 1,400-lb pressure . . . The primary field for high-pressure steam in industry is in the process industries—chemical works, soap plants, rubber factories, paper mills and so on. Here conditions place two definite limitations on steam pressure. The first is economic, the ratio of power to process load. If you can get all your power as a byproduct with 500-lb boiler pressure there is obviously no sense in going to 800 lb or 1,400 lb. . . . Secondly, most process power plants deliver a lot of low-pressure steam which never returns to the boilers as condensate. Boiler makeup may run anywhere from 50 to 100%. For such high percentages, evaporators are rarely used because of the capital investment required. That means that the raw feedwater must be chemically treated, which, in turn, may put some limit on the pressure which can be carried . . . I have been interested to learn just how high a pressure may be safely carried with 100% chemically treated makeup. The present accepted limit seems to be about 900 lb. Weirton Steel (see *Power*, July and mid - September, 1937) is the outstanding example. The makeup is treated in hot-process lime-soda softener and then deaerated. Secondary phosphate treatment is introduced at the feed-pump suction. Continuous blowdown keeps the solid concentration in the boiler water under 2,500 ppm. A steam washer in the boiler drum gives additional insurance against carryover.



. . . 100% chemically treated

I was talking the other day with a consulting engineer who has much to do with the heating and ventilating and other mechanical equipment in the buildings of a large city. He confirmed my impression that the mechanical equipment of many of these buildings is in very bad shape and wasting money at such a terrific rate that a little commonsense modernization would pay rich dividends. Some of the fault, he felt, lies with the operating engineers, but he trained his big guns on the bankers . . . Depression bankruptcies put bankers into the real-estate business in a big way. Some of them, apparently, are trying to apply the old formula for getting rich: *"Work like hell and don't spend a damn cent."* As far as building operation is concerned, only the first half of this formula is any good. Every cent you don't spend to put decrepit equipment in shape leaks out as dollars through the operating bunghole . . . I wouldn't indict the whole profession. Not all bankers are this way, but some of those who bring the mental attitude of the counting house to difficult problems of engineering economics have *yet to learn the ABC's* of building operation. The first is to hire managers and engineers with a practical understanding of building operation. The second is to pay attention to their recommendations.

. . . work like hell

. . . the ABC's

FEEDWATER TEST EQUIPMENT

For a Small Plant

By R H Sogard
SUPT DEPT OF BLDGS & GROUNDS
UNIVERSITY OF MISSOURI

AT THE UNIVERSITY of Missouri power plant (Columbus, Mo.), is a convenient and inexpensive arrangement of apparatus for testing feedwater, located in one corner of the turbine room. The left-hand compartment in the cupboard below the bench, Fig. B, is used for bulk storage of test chemicals, while the one on the right stores a portable turbine-oil blotter press. The light at the upper left has a daylight lamp.

In Fig. A, the left-hand cabinet contains reagents and distilled water on the top shelf, and indicators and glassware on the two bottom shelves. A small wood frame holds filtration funnels.

Under the large right-hand cover are burettes for reagents and samples. Four small burettes on the left contain 25 cc each and are graduated to 0.1 cc with blue-line graduations. Diagonal-bore cocks on these burettes permit very accurate control of reagent quantities. Large 250-cc burettes, graduated to 1 cc, on the right measure samples, allowing accurate control of sample size.

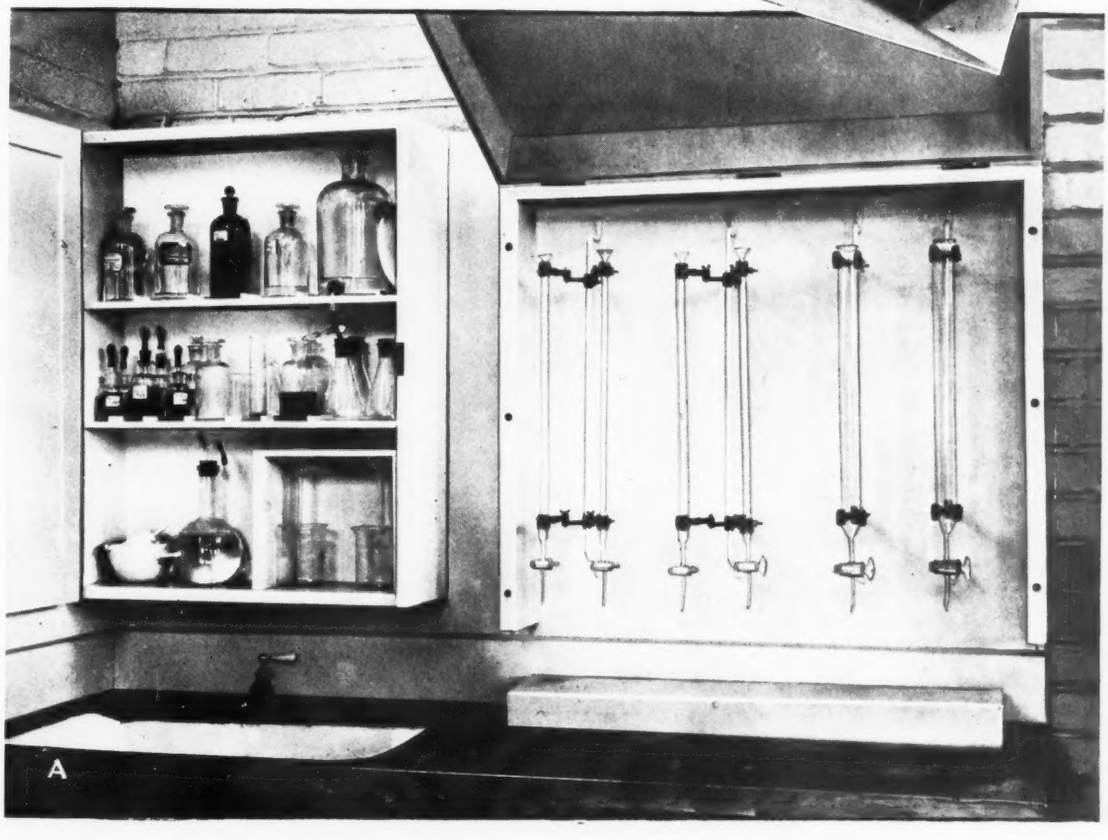
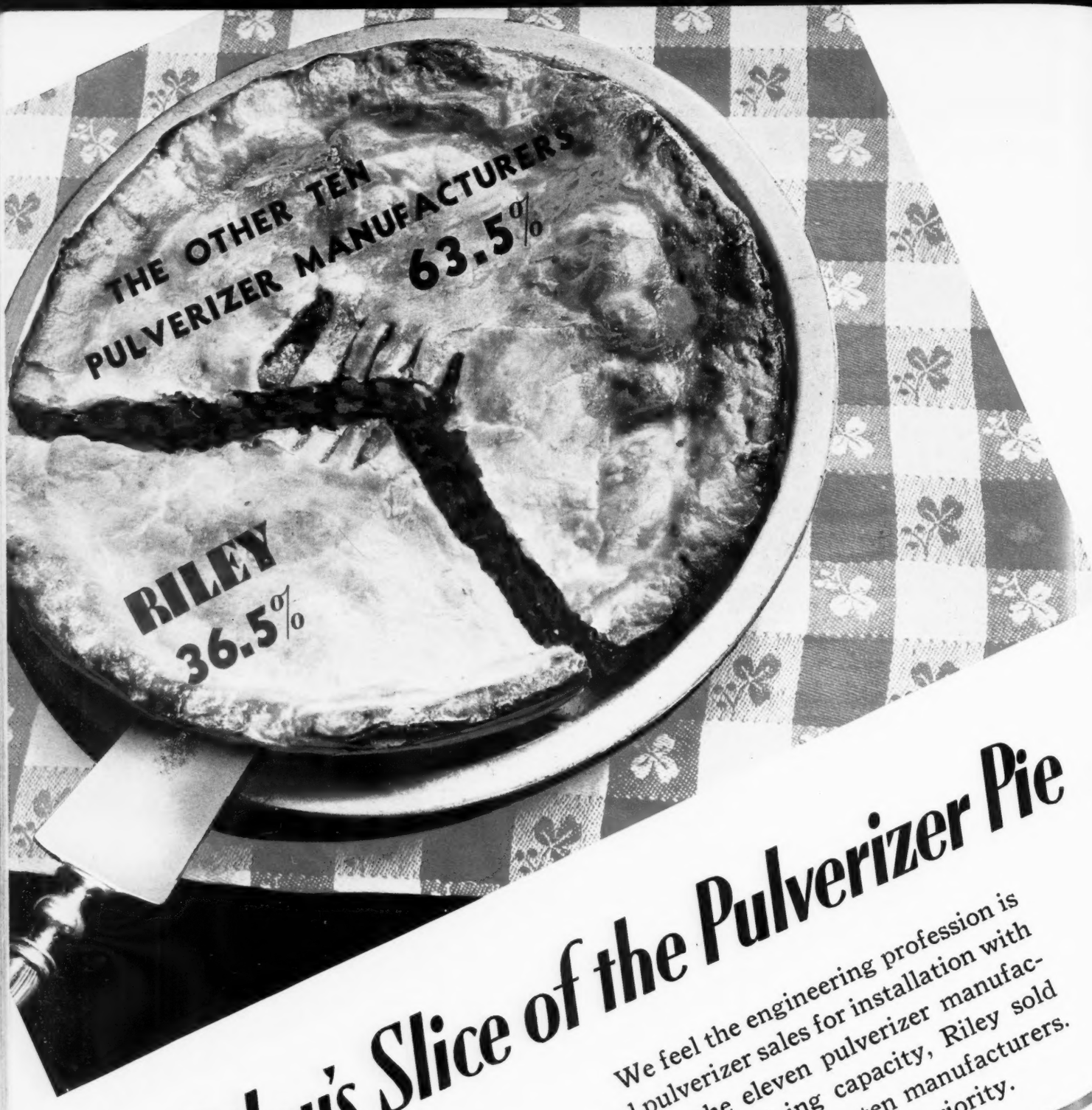


Fig. B—Cabinet that contains all the equipment for feedwater testing is located in one corner of the turbine room. Fig. A—Chemicals and apparatus are close at hand in the upper part of the cabinet



Riley's Slice of the Pulverizer Pie

We feel the engineering profession is entitled to know these facts about coal pulverizer sales for installation with water tube boilers. Of the total sales of the eleven pulverizer manufacturers to date in 1935, based on coal pulverizing capacity, Riley sold 36.5%, leaving only 63.5% to be divided by the other ten manufacturers. Could there be any better evidence of Riley Pulverizer Superiority.

A Few Rec

American Laundry Machinery Co.
Owens-Illinois Glass Co.
Carbide & Carbon Chemical Co.
Titanium Pigment Co.
Beechnut Packing Co.

Crompton &
Arnold Prin
Crystal Ti
Ames Wo
Norton

The SWING- *to* **RILEY** *continues*

Advertisement
of September 193

RILEY continues to enjoy their slice of the Pulverizer Pie

Riley continues to enjoy considerably more than their proportionate share of the country's pulverizer sales. Some of the largest pulverizer orders ever placed in Riley history have been sold during the past eighteen months. Cahokia placed a repeat order for 10-20,000 lbs. per hour Riley mills, one of the largest pulverizer contracts of the past five years. 1937 is the biggest year in Riley history.

Riley has been able to maintain this favorable position by continually carrying forward the development of Riley pulverizers and burners. Improvements in design and in materials of manufacture have not only added to the performance efficiency of Riley pulverizers but have also materially reduced maintenance.

Riley pulverizers continue their leadership in these important factors of operation.

1 General design

2 Fineness of pulverization

3 Sustained and consistent fineness maintained throughout life of pulverizing elements

4 Lower power rate

5 Flexibility . . . wide load range

6 Quiet, vibrationless operation

7 Low maintenance

8 Ease of lighting

9 Ability to handle wet coal

10 Reliability

11 Record of and satisfactory performance of the large number of existing installations

You should thoroughly investigate Riley pulverizers.

In addition to pulverized fuel equipment, Riley also manufactures and installs all types of fuel burning equipment and complete steam generating units.

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PULVERIZERS - BURNERS - MECHANICAL STOKERS - STEEL-CLAD INSULATED SETTINGS

Partial List of Riley Pulverizers Sold or Installed within the past year

POWER OPERATING CO., Cahokia Station
(Repeat Order)
10—20,000 lbs. of coal per hour pulverizers
CARNEGIE-ILLINOIS STEEL CO., Ohio Works, Youngstown, Ohio
(Repeat Order)
2—28,500 lbs. of coal per hour pulverizers
CITY OF SPRINGFIELD, ILL.
(Repeat Order)
4—9500 lbs. of coal per hour pulverizers
HARTFORD ELECTRIC LIGHT CO., CONN.
(Repeat Order)
4—18,000 lbs. of coal per hour pulverizers
TENNESSEE ELECTRIC POWER CO., Chattanooga, Tenn.
2—19,000 lbs. of coal per hour pulverizers
2—9500 lbs. of coal per hour pulverizers
W. VA. PULP & PAPER CO., Williamsburg, Pa.
(Repeat Order)
3—9000 lbs. of coal per hour pulverizers
Charleston, S. C.
(Repeat Order)
4—14,250 lbs. of coal per hour pulverizers
Luke, Md.
(Repeat Order)
1—28,500 lbs. of coal per hour pulverizer
Covington, Va.
(Repeat Order)
3—18,000 lbs. of coal per hour pulverizers
LYNN GAS & ELECTRIC CO., Lynn, Mass.
3—14,250 lbs. of coal per hour pulverizers
GENERAL ELECTRIC CO., Bridgeport, Conn.
4—9000 lbs. of coal per hour pulverizers
CARBIDE & CARBON CHEMICAL CO., S. Charleston, W. Va.
(Repeat Order)
4—14,250 lbs. of coal per hour pulverizers
SHELL PETROLEUM CO., Wood River, Ill.
8—9500 lbs. of coal per hour pulverizers
WHEELING STEEL CORP., Portsmouth, Ohio
(Repeat Order)
2—9500 lbs. of coal per hour pulverizers
WINCHESTER REPEATING ARMS, New Haven, Conn.
2—6750 lbs. of coal per hour pulverizers
WESTERN CARTRIDGE CO., E. Alton, Ill.
3—5250 lbs. of coal per hour pulverizers
GUIDE LAMP CO., General Motors Corp., Anderson, Ind.
1—6000 lbs. of coal per hour pulverizer
CELANESE CORPORATION, Cumberland, Md.
2—14,250 lbs. of coal per hour pulverizers
HEYWOOD WAKEFIELD CO., Gardner, Mass.
(Repeat Order)
2—4500 lbs. of coal per hour pulverizers
PORT HURON SULPHITE & PAPER CO., Port Huron, Mich.
2—9000 lbs. of coal per hour pulverizers
HARTFORD CITY PAPER CO., Hartford City, Ind.
2—9500 lbs. of coal per hour pulverizers
JOHN MORRELL CO., Ottumwa, Iowa
(Repeat Order)
2—9500 lbs. of coal per hour pulverizers
UNIVERSITY OF MINNESOTA, Minneapolis, Minn.
2—14,250 lbs. of coal per hour pulverizers
MACANDREWS & FORBES CO., Philadelphia, Pa.
4—9000 lbs. of coal per hour pulverizers
NATIONAL CASH REGISTER CO., Dayton, Ohio
(Repeat Order)
2—9000 lbs. of coal per hour pulverizers
LEWISTON BLEACHERY, Lewiston, Me.
1—14,250 lbs. of coal per hour pulverizer
UNIVERSITY OF MARYLAND, College Station, Md.
2—4500 lbs. of coal per hour pulverizers
ST. CROIX PAPER CO., Woodland, Me.
(Repeat Order)
2—14,250 lbs. of coal per hour pulverizers
OWENS-ILLINOIS GLASS CO., Newark, Ohio
2—6000 lbs. of coal per hour pulverizers
CITY OF FAIRBURY, Nebraska
1—6000 lbs. of coal per hour pulverizer
CRYSTAL TISSUE PAPER CO., Middletown, Ohio
1—9000 lbs. of coal per hour pulverizer
FOSTER PAPER CO., Utica, N. Y.
1—4500 lbs. of coal per hour pulverizer
JOS. E. SEAGRAMS & SONS, Louisville, Ky.
(Repeat Order)
2—9500 lbs. of coal per hour pulverizers
KROGER GROCER & BAKING CO., Columbus, Ohio
(Repeat Order)
2—4500 lbs. of coal per hour pulverizers
DOWNINGTOWN PAPER CO., Downingtown, Pa.
1—4500 lbs. of coal per hour pulverizer
S. J. BRISBIN CO., South America
1—9000 lbs. of coal per hour pulverizer
RIVERSIDE METAL CO., Riverside, N. J.
1—9000 lbs. of coal per hour pulverizer
UPPER MICHIGAN POWER & LIGHT CO., Escanaba, Mich.
3—6000 lbs. of coal per hour pulverizers
MILWAUKEE DOWNER COLLEGE, Milwaukee, Wisc.
1—2000 lbs. of coal per hour pulverizer
MARBLEHEAD LIME CO., Chicago, Ill.
(Repeat Order)
2—2000 lbs. of coal per hour pulverizers

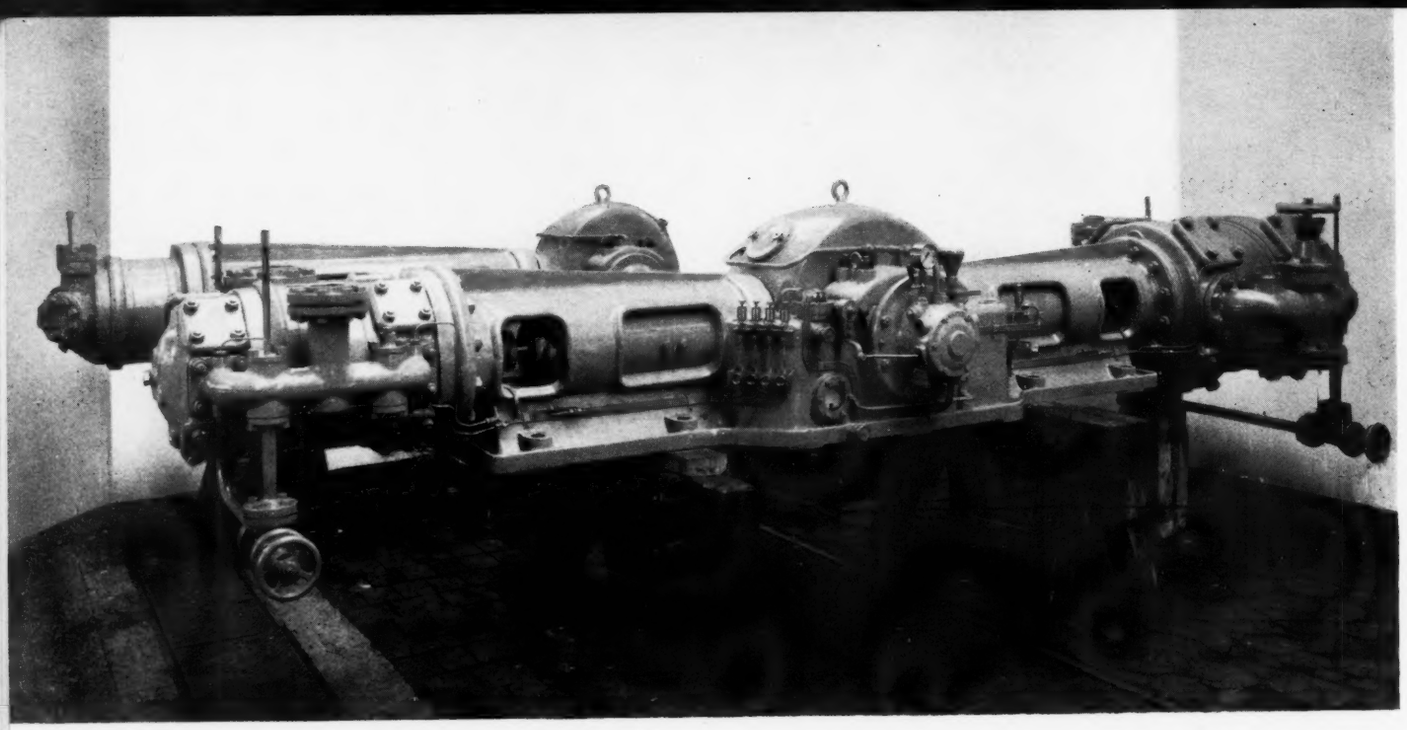
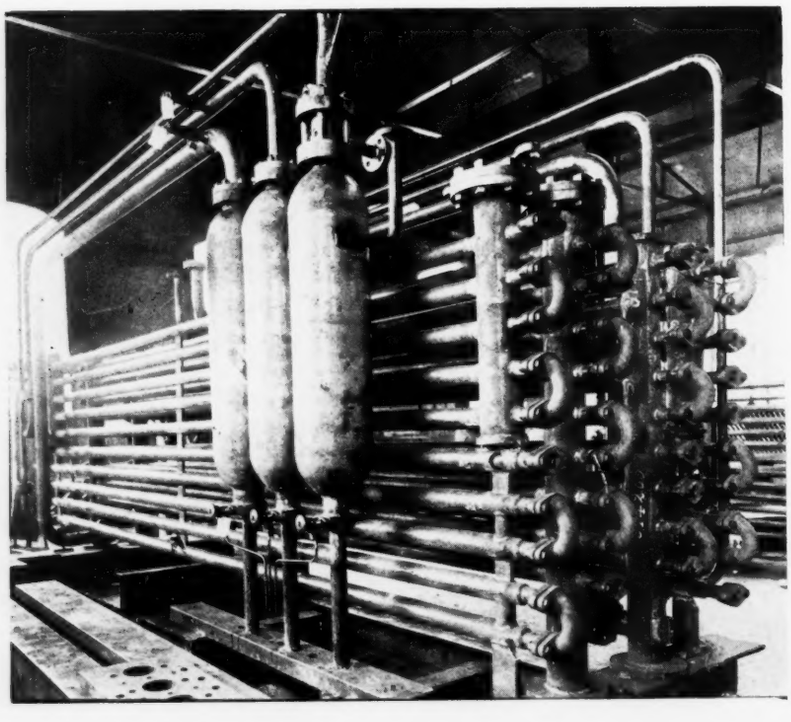


Fig. 1—3-stage horizontal compressor for CO_2 liquefaction plant

CO_2 COMPRESSORS IN EUROPE

Fig. 2—Counterflow intercooler with oil separators



WHILE NEWER refrigerants with long names have tended to crowd CO_2 out of air conditioning and refrigeration, in the field of dry-ice manufacture CO_2 enjoys an obvious monopoly. Compressors for this service must meet requirements of high temperature and low pressure at the compressor inlet, whereas the gas returned to a refrigerating unit is usually at low temperature and relatively high pressure.

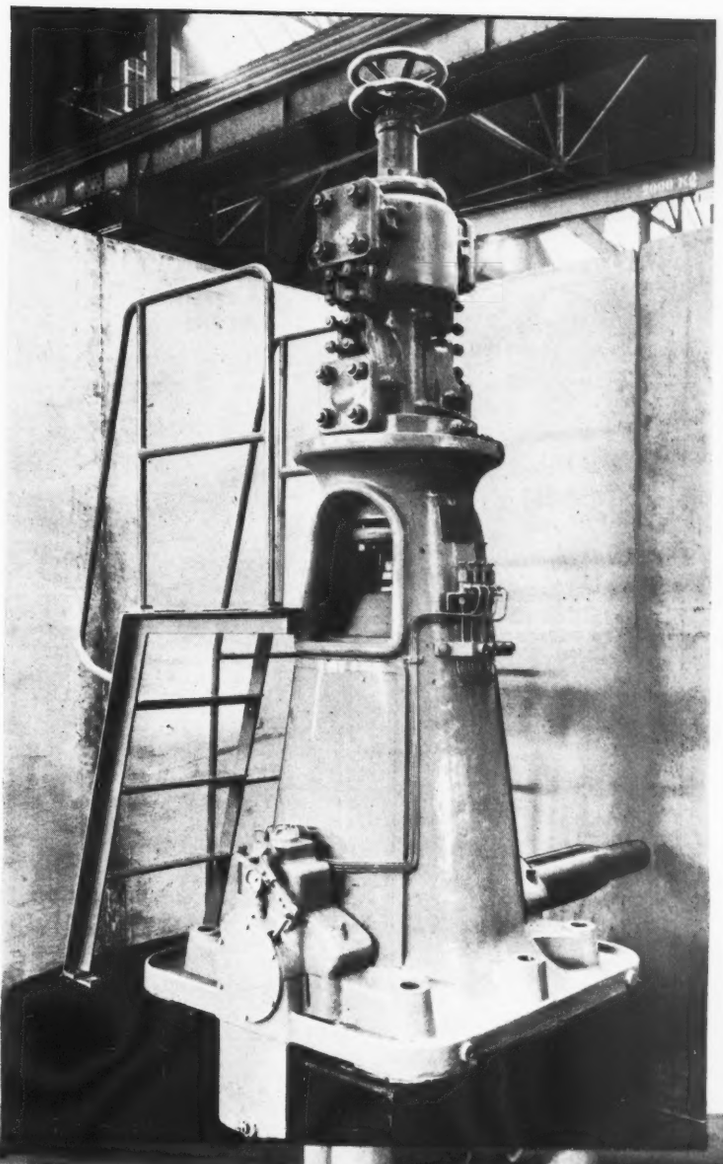
The three compressors illustrate European types for dry-ice manufacture, ice-making and refrigeration. Fig. 1 is a 3-stage horizontal unit with the first two stages oppositely disposed on the same crosshead and the third stage alongside in a twin arrangement coupled by a common shaft. The two cylinders of the first stages are double-acting, the third stage has a single-acting plunger piston. Intercoolers and oil separators for this compressor are shown in Fig. 2.

Dry ice is made by liquefying carbon dioxide and then permitting a part of the liquid to evaporate. The heat taken away by evaporation of a small fraction of the liquid is sufficient to freeze the remainder. Liquefying compressors have to be built with at least three stages with interstage cooling to keep temperatures within reasonable limits and avoid heavy wear of cylinders and packing glands.

Fig. 3 shows a 2-stage compressor for making ordinary ice. Of different appearance and design, this unit is of considerably higher capacity than the compressor of Fig. 1. Designed for intermittent operation and variable output, the unit has a special device for regulating output, shown at the upper cylinder end. Gas is received at low temperature so that only one stage is provided with a cooling jacket.

Compressors in the refrigerating room of a modern sausage and preserved-meat-packing plant are shown in Fig. 4. These two 16.5-ton CO_2 units are direct-connected to 375-rpm electric motors and their operation is fully automatic.

Abstracted from articles in *Escher Wyss News* (Switzerland) by D. Mettler and A. Ostertag.



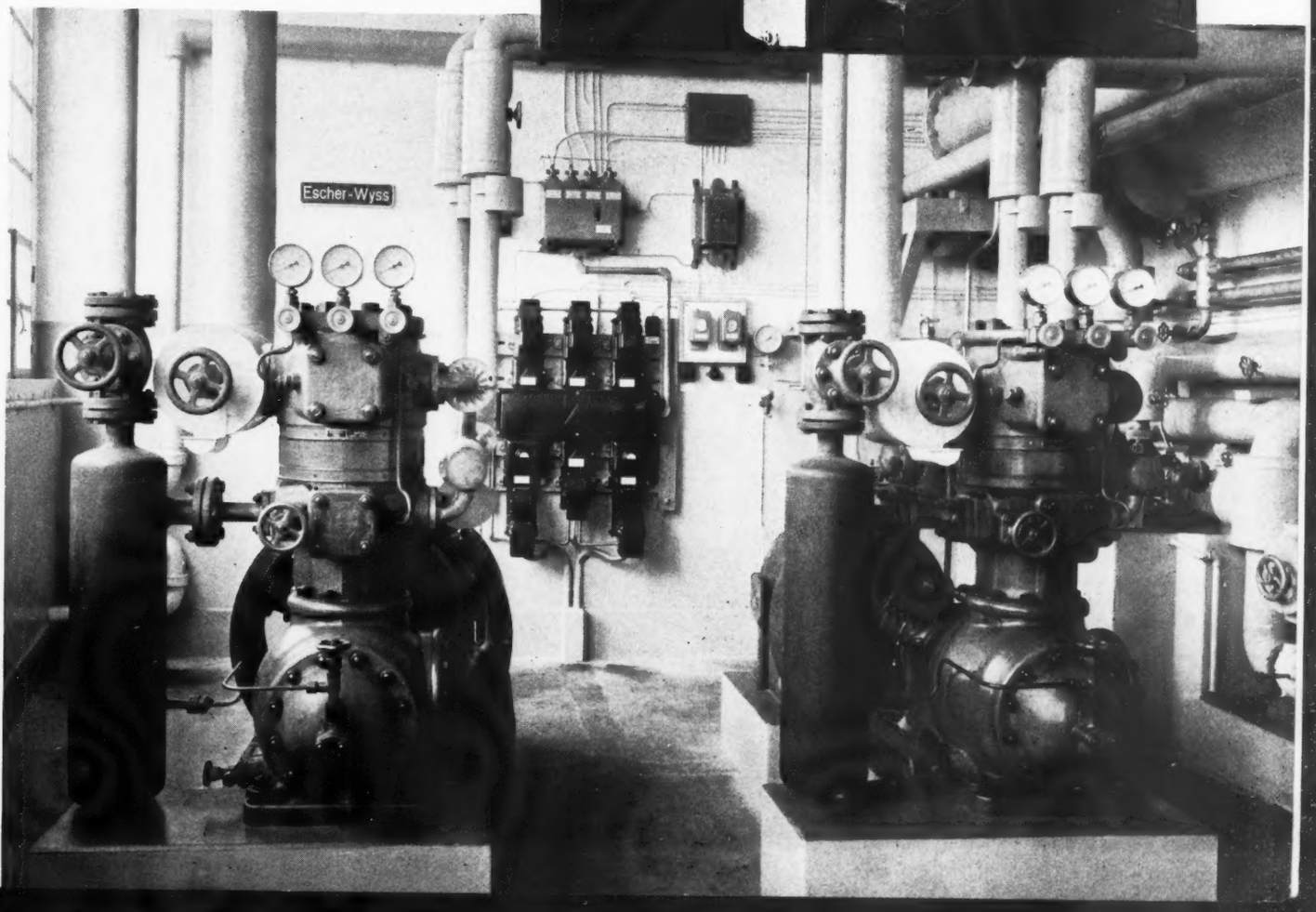
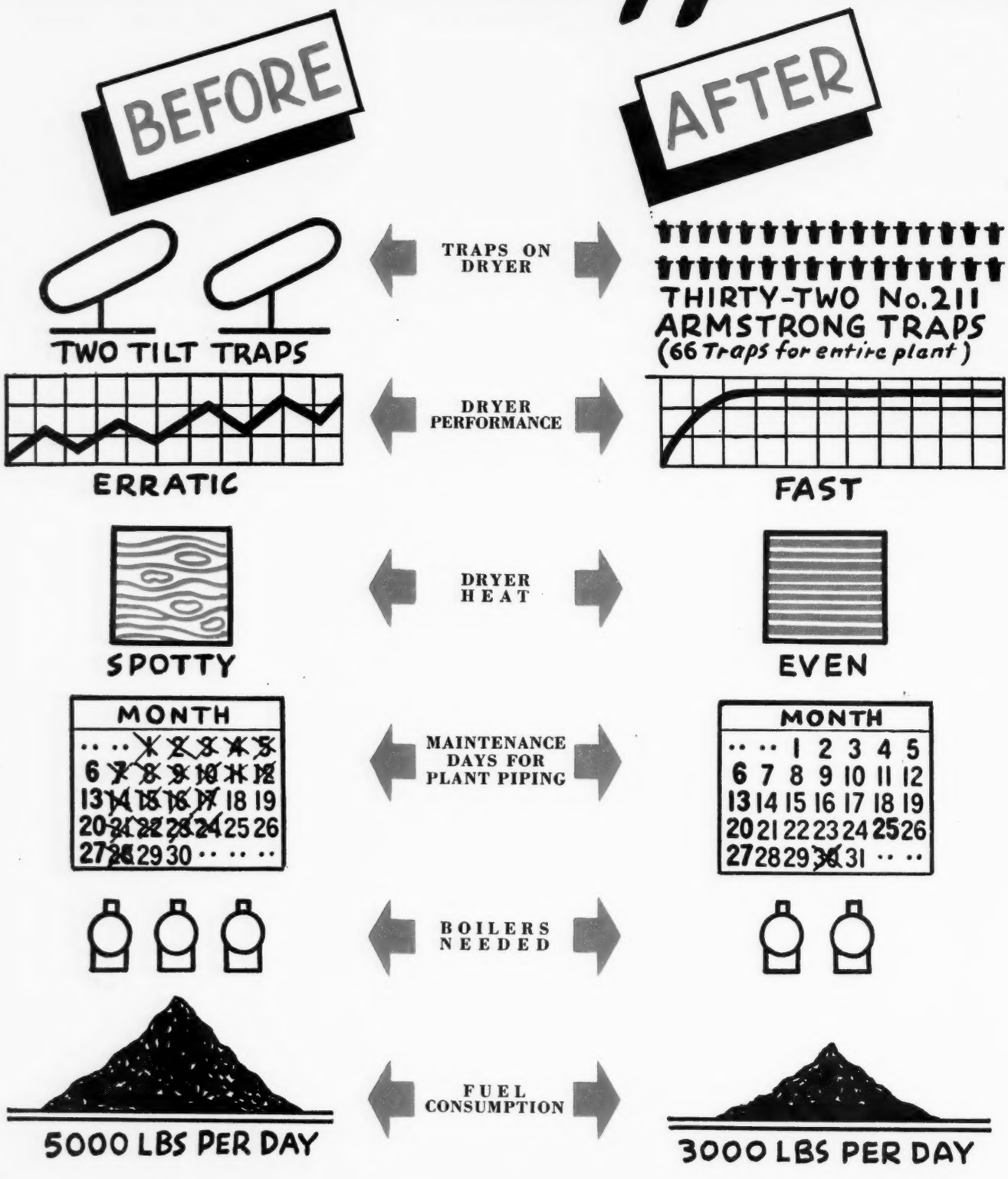


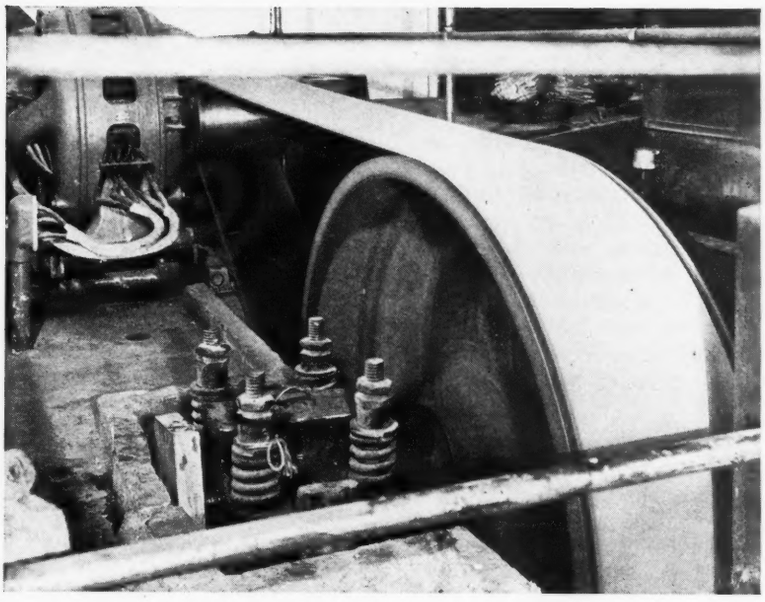
Fig. 3 (right)—2-stage ice compressor with output-regulating gear on upper cylinder end. Fig. 4 (below)—Two 16.5-ton single cylinder plunger-piston compressors in a sausage factory

GLAD they put in



ARMSTRONG "INVERTED BUCKET" STEAM TRAP

Rx for ENGINEERS, too



Small drive pulley and close shaft centers characterize modern motor drives, as in this one where an 18-ft belt connects a 200-hp motor to a high-speed paper-mill beater

Here's to Long Life **for Your Belts**

A comparison of yesterday's conditions and those found in present-day practice and some suggestions that will insure long belt life and reliable service

WHEN ONE BELT gives more than 75 years of service and another fails in less than that number of days, the question naturally arises, "Why?" It must be admitted that both cases are exceptions, but they are of interest to the belt manufacturer and user alike. The belt user is interested in how he can get longer service from belts in his plant. If a belt has short life, it is frequently put up to the manufacturer to answer the question, "Why?"

A belt that has seen 75 years of service dates back into those good old days when leather was supposed to be made better than it is today. Be that as it may, belts operated under more favorable conditions then than now, as a general rule. Most of the very long-life belts connect steam engines to lineshafts or similar drives. A belt on one of these drives is operating under entirely different conditions than belts on most modern drives. For example, an engine drive might have a 10-ft flywheel connected to a 4-ft pulley by a belt 60 ft or more in length. Compare this with what would be considered a favorable modern drive, where an 8-in. pulley on an 1800-rpm motor drives a 20-in. pulley by a belt 20 ft long.

If we assume both belts to be operating at the same speed, the short belt bends over its pulleys three times as frequently as the long one. Other conditions being equal, belt wear should be three times as great due to bending over the pulleys and to the action of the pulleys on the surface of the belt. But conditions are not equal. Bending stresses are far more severe in a belt running over an 8-in. pulley than on one 48 in. in diameter.

Shock Loads

The long belt is far more elastic than the short one and is therefore not subjected to the stresses due to shock or fluctuating loads that short belts are. Shock loads have a marked effect upon belt life. Unless the drive has been liberally designed, peak loads will overstress the belt and cause burning of its inner surface.

With individual drive, shock or peak loads are likely to be far more important than in group drives where the peak of one load may fit into the valley of another. For the same reason belts on group drives are less likely to be overloaded than on individual drives.

When we compare the life of a high-grade modern belt with one made in the good old days, and take into consideration all factors that effect their life, it will be found that one will give about as good service as the other, when properly selected, installed and maintained.

Influencing Factors

Where short life is experienced with a high-grade belt, let it be leather or rubber, the cause can generally be traced to ignoring factors that influence belt life. First, there are conditions of acid and other fumes, excessive heat, moisture and oil where belts should not be used. If they are used in these places they should not be blamed for the inevitable.

Overloading is probably the most common cause of short belt life. A belt should be selected for the maximum load that it must pull, not the average. The maximum load may be peaks that occur during normal operation, or severe starting conditions. Whatever the cause, peaks must be taken into account and a belt selected with sufficient capacity to operate without excessive tension.

Next to the proper selection of the belt is its installation. Wherever possible, the belt should be made endless. Methods are now available for making rubber belts endless almost as readily as leather. Be sure the ends of the belt are square and properly lined up before making the splice. No matter what type of joint is used, it must be properly made and maintained. Renew fasteners when they show signs of serious wear; worn fasteners make joints break and tear.

Although proper selection and installation are the most important factors in good belt service, just as they are for any other type of equipment, it must be given a reasonable amount of care after installation. Run the belt as slack as possible and yet avoid slip. Mount motors on bases of correct design that automatically maintain correct tension in the belt. Keep the pulleys and shafting in line so that the belt will run true. Keep the belt clean and, if necessary, treat it with a good belt dressing. Keep oil from getting on the belt. Attention to these factors will pay many times over in increased belt life and uninterrupted service.

CHICAGO POWER SHOW

In which the national spotlight was focused on power generation and equipment developments as it has never before been done in the Middle-West

FOR SIX DAYS, Oct 4 to 9, attention of engineers was centered on the Chicago Exposition of Power and Mechanical Engineering, held in the New International Amphitheatre, Chicago, Ill. Power equipment was exhibited by 153 companies from 31 states (see page 705).

Practically every type of power-plant equipment and many industrial-power applications were represented. Mechanical-power-transmission equipment manufacturers had one of the largest exhibits, which included motorized speed reducers, gears, flat belts, multiple-V belts, silent chains, roller chains, variable-speed transmissions, friction clutches, free-wheeling clutches, pulleys, belt fasteners, in many designs, both anti-friction and sleeve bearings, pulley and gear pullers and kindred equipment. These exhibits demonstrated that mechanical - power - transmission equipment manufacturers are awake to the needs of industrial-power applications and are making a tremendous effort to meet these demands.

Belt manufacturers showed a leather belt that had a maximum horsepower capacity of three times that of some of the older designs. High coefficient of friction is very important in a belt, for it permits operation at normal tension to drive rated load, but at the same time provides the necessary capacity to carry peak loads without serious slip. Such belts have long life because of their high quality and low initial tension when properly applied. They also increase production because of their ability to transmit peak loads with only slight slip.

Variable-speed transmissions were presented in many forms, from low-cost simple devices in sizes down to $\frac{1}{8}$ hp to expensive hydraulic designs for very exacting applications, requiring very close speed control from zero up to several hundred rpm. One transmission could provide a wide range of speed adjustment from zero in either direction of rotation. In another booth, variable-speed transmissions were applied to driving a sectionalized machine such as used in paper and textile manufacturing. By means of tension control, the variable-speed transmission maintained each machine section at correct speed.

It has generally been considered good practice to avoid vertical silent-chain drives. At one booth it was demonstrated that by the use of a shoe to take slack out of the chain, these drives could operate as satisfactorily as horizontal applications. Silent chains that could drive from both sides and operate with reverse bends were also shown.

Among the clutch exhibits, a free-wheeling type held the center of interest. In operation, this clutch is absolutely positive without any backlash, but permits overrunning of the load with very low friction. The clutch may also be used for ratchet-drive applications.

Diesels and Air Compressors

Among the exhibits of large equipment was a 160-hp, 850-rpm diesel and a 25-kw, 1,200-rpm diesel unit with the generator and its direct-connected exciter supported directly from the end of the engine frame. Because of the high speed of the engine this unit is very compact and can be set up most anywhere.

The largest air compressor was a 410-cfm, 2-stage, 100-lb unit driven at 600 rpm by a direct-connected 75-hp synchronous motor. This angle-type unit with high- and low-pressure cylinders set 90 deg apart is mounted so that each cylinder makes a 45-deg angle with the floor. Because of the short stroke of this compressor, 7 in, its piston speed is only 700 ft per min. A 206-cfm and a 87-cfm compressor, driven by a 75-hp induction and a 20-hp induction motor respectively, had their motors mounted directly on the compressors and connected to them by multi-V belts, giving a very compact design. A new aftercooler and separator were included in this exhibit.

Refractories and Insulation

Furnace-refractories and heat-insulation exhibits included brick, tile and plastic forms. One form of tile design permitted any type of construction, arch, wall or ceiling, to be hung from steel forms so that expansion could take place in any direction. Only four shapes of castings and a maximum of four shapes of tile are required to make any arch and arch nosing from 30 to 135 deg.

A large inclined traveling-grate stoker was shown that had a grate made up of alternate traveling and stationary sections and an ash-retarding assembly, grate-supporting center, and side frames. In this design, instead of the fuel passing through the furnace at constant speed, the coal is subjected to retarding action of the stationary grates and the fuel bed moves more slowly as it approaches the discharge end of the grates. This action prevents thinning of the fuel bed as it burns. At the rear of the stoker, cover plates retard the ashes so that considerable pressure is required to push them into the pit.

Steel, copper, brass and other types of tubing and fittings for practically every purpose were exhibited. An electrically-welded boiler tube was shown in which the weld could not be detected. Sections of these tubes could be flattened, with one of the bends in the weld, until the two sides were together without the weld showing distress. This test is equivalent to two-thickness flattening (the ASME test requires only three-thickness flattening).

Valves and fittings for high-pressure high-temperature steam were featured in several booths. These could be had for either flanged-bolted connections or for welding into the lines. Much has been said about the high quality of modern welding. One manufacturer showed samples of some of these welds. One sample, a 1.75-in bar of carbon steel with a weld in the center, taken from a pipe, was given a free bend test until the two pieces of parent metal each side of the weld almost came together. This caused 108% elongation in the outer fibers of the weld, without serious signs of failure in the weld.

Air-Conditioning

Air-conditioning, air-filtering and flue-gas-cleaner equipment were much in evidence. For industrial purposes, several types of air filters were demonstrated, both stationary and the traveling self-cleaning types. Other types clean the air in foundries and other places where there is danger of workers contracting silicosis.

The importance of lubrication in industry was emphasized by the number of lubrication exhibits. Several centralized pressure systems could be used to lubricate all bearings on a large machine, or lubricate all machines in one department from a central pressure source.

Power Applications Feature AISEE Convention

8 technical sessions, 25 papers, 2 inspection trips and a record exposition feature this year's meeting

TWENTY-FIVE technical papers and inspection trips to two of the largest steel mills in the world were the highlights of the 33rd Annual Convention of the Association of Iron & Steel Engineers, at the Stevens Hotel, Chicago, Ill., Sept 28 to Oct 1. The two trips were to the Gary, Ind, sheet and tin-plate mill of Carnegie-Illinois Steel Corp, and to the hot and cold strip mills of Inland Steel Co, Indiana Harbor, Ind.

Officers elected for next year are: president, L F Coffin, supt Mechanical Dept, Bethlehem Steel Co, Sparrows Point, Md.; 1st vice-president, C C Wales, asst general manager, Algoma Steel Corp, Ltd, Sault Ste. Marie, Ontario; 2nd vice-president, W A Perry, supt Electrical and Power Dept, Inland Steel Co, Indiana Harbor, Ind.; treasurer, F E Flynn, general manager, Republic Steel Corp, Warren, Ohio; and secretary, J L Miller, asst combustion engineer, Republic Steel Corp, Cleveland, Ohio.

Several of the papers presented at the meeting were of particular interest to power engineers. Of these, "Steam Generation from Gas-Engine Exhaust in America," by T A Lewis, is given in considerable detail on pages 669-71 in this issue of *Power*.

Power Plants

After reviewing the tremendous developments in the power-plant field during the last 25 years, Charles W E Clarke, consulting engineer, United Engineers & Constructors, Inc, said that with the steam cycle of today it is entirely feasible to obtain over-all plant thermal efficiencies of about 30%. Ten years ago 23% would have been considered excellent performance. These advances have been made possible by chrome, nickel and molybdenum alloys that allowed construction (in machines, piping connections and other pressure parts of generating plants) which copes with the increased stresses and permits safe use of the high pressures and temperatures which have been developed. The highly developed welding art has been extremely effective in allowing efficient production not only of

L. F. Coffin, president

boiler parts, but of piping systems, allowing the welding-in of valves and obviating the need for flange joints. A better knowledge of the physical properties of steam has also been a contributing factor to the progress that has been made.

Steam Turbines

C B Campbell, turbine engineer, Westinghouse Electric & Manufacturing Co, in a very comprehensive paper, reviewed steam-turbine developments and their applications in the steel industry. It was Mr Campbell's opinion that the most important problems characteristic of steam-turbine applications in steel-mill power plants are probably those associated with control. These are found in connection with partial use of steam from waste-heat boilers, as well as in the problem of control under the large and rapid swings of rolling-mill loads, either with or without the complications introduced by a combination of generated and purchased power.

Recent developments, said Mr Campbell, have vastly enlarged the possibilities of perfecting the operation of isolated plants in relation to purchased power and the control of the interchange of power between 25- and 60-cycle generating units within a plant, with or without partial waste-heat steam generation.

The fundamentals of cable engineering, advances made in the art of cable manufacture, and the importance of many factors in cable selection, were discussed by F L Aime, S J Rosch, and R B Steinmetz, of Anaconda Wire & Cable Co. It was pointed out that conditions of installation naturally have a direct bearing on the application of cables for satisfactory results. The factors that must be recognized in the installation of cables are size, location and condition of duct banks, conduits or other cable locations; presence of nearby furnaces, steam and hot-water pipes, or hot spots; presence of moisture, solvents and corrosive ingredients; freedom from mechanical damage during installation; freedom from vibration; training of cables; jointing methods and workmanship; selection and installation of potheads when required; grounding and bonding of lead-sheathed cables; and fireproofing.

Methods of operation have a decided influence on the reliability, maintenance and cable life. Some of the important factors to receive consideration in cable operation include protection against overload and overvoltage; protection from external heat; protection against mechanical damage; routine inspection for protection against corrosion and electrolysis (if metallic sheath is used); and cable-sheath grounding.

Test Engineers

After outlining the work of an electrical-testing department of a large steel plant, Birger Thele, test engineer, Tennessee Coal Iron & Railroad Co, said that an electrical testing department, if properly used, will pay for itself by safeguarding the expensive electrical equipment, thus preventing many costly failures and delays. In case of failure it can save the expense of unnecessary long shutdowns by correct analysis of the trouble or by prompt location of the fault. It can also effect a saving for its company by keeping a cost check on all power requirements and by discovering wasteful practices.

The work of electrical testing departments is never finished, said Mr Thele. Opportunities for the services of this department are as many and

(*Continued on page 704*)

ASME Holds First Fall Meeting

Many power papers included in diversified program, which also features unusual inspection trips

FOR YEARS the American Society of Mechanical Engineers has had its annual meeting in New York and a spring meeting at some other center (this year in Detroit). To this schedule has now been added a fall meeting, the first of which drew 250 engineers to the Hotel Lawrence, Erie, Pa., Oct 4-6. Programs gave attention to power, process, machine shops, industry, instruments, personnel and research. Social features included a luncheon and a banquet and inspection trips were taken to Erie Forge, American Sterilizer, General Electric and Hammermill Paper.

Calorized "Moly"

Possible power applications for calorized high-molybdenum steel were suggested by C L Clark, Univ of Mich, and R S Brown, The Calorizing Co, in "A New Low-Alloy Pearlitic Steel for High-Temperature Service". They had investigated calorized 1.5% moly steel at high and at room temperature, the moly providing strength and the calorizing resisting corrosion. Good load-carrying ability was retained to 1300 F. Primary power applications suggested were in radiant superheaters. Convection-superheater use may be limited because the material cannot be bent to a radius under 5 or 6 tube diameters.

Some discussers felt that superheaters can be designed to provide the necessary large radii. J W Parker, vice-president and chief engineer of Detroit Edison, said that calorizing helps plain carbon-steel tubes in the hottest part of the superheater in their tests with 1100-F steam.

At the same session, R H Boas of E M Gilbert Engrg Corp reviewed rehabilitation of Station No. 3 of Rochester (NY) Gas & Elec Corp. Prior to 1936, steam at 200 lb and 525 F was supplied to turbines with jet condensers. In all, six turbines totalled 65,000 kw, and 22 boilers totalled 165,000 sq ft of heating surface. Existing low pressure and temperature, the necessity of retiring old boilers, and other conditions, called for a top. It was decided to continue using the jet condensers, providing boiler and feed-treating equipment to permit operation at 700 lb with 100% makeup.

The 1935 extension covered a 250,000-lb-per-hr boiler supplying steam at 650 lb and 750 F to a 6000-kw topping turbine. The feedwater purification system included double softening, first by lime and soda in an intermittent system (now being made continuous) then by phosphate in a hot-process softener. Water is finally filtered through a non-siliceous medium. Double deaeration is effected, first in the reaction tank of the phosphate softener, then in the storage department of this tank, from which softened water is discharged through filters. A secondary dose of phosphate is applied directly to the boiler drum.

Operation to date has been very satisfactory, without scale formation or corrosion in boiler, economizer or superheater. Deposits on the feedwater-regulating valve were partly controlled by limiting excess soluble phosphate in the water, then later completely overcome with sulphuric acid. Phosphate sludge accumulation in the rear drum and in tubes feeding the mud drum has been too slow to cause difficulty. The boiler can be operated 6 months or longer without shutdown for cleaning.

A steam washer was designed in cooperation with the boiler manufacturer to scrub contaminated saturated steam with feedwater before delivery to the superheater. Tests indicate that solids in steam leaving the boiler are only 0.3 to 2.0 ppm, in spite of the high boiler-water concentration of 3,000 to 3,500 ppm.

A duplicate boiler and turbine were installed in 1936, and at the same time the 7,500-kw house turbine installed in 1912 was replaced by a 7500-kw, 3600-rpm unit at 200 lb and 525 F. Its jet condenser was replaced by a surface condenser which partially preheats feedwater. This in turn reduces the amount of chemicals required for treatment.

With two 250,000-lb-per-hr boilers in service, six old boilers can be removed to make way for the third new one. A fourth will be added within two years as a spare. The two new topping turbines supply enough steam for present low-pressure turbines, so the next step must be a condensing 25,000-kw, 3600-rpm unit of welded-hood construction with hydrogen-cooled generator and surface condenser. All new boilers are on a common main. Condensate from the condenser, as well as from the 7500-kw house turbine, discharges into a common mixing chamber with makeup.

Discussion

I E Powell of Rochester Gas & Electric in discussion said that the boiler is cooled down and washed out every 90 days. The steam purifier is easily washed and does not seriously interfere with access to the boiler. After three months operation, they found no deposits on turbine blades. Since then there has been no loss of capacity or efficiency and no fouling of superheater tubes. W E Caldwell of Consolidated Edison wrote that while some industrials are operating with high pressure and high makeup, none carry such a high concentration as Rochester. He asked whether 1200 lb and 900 F might not be feasible with 100% treated makeup. Higher concentration means a substantial saving in blowdown losses.

S T Powell, consulting engineer, said that No. 3 is a pioneering installation because of water conditions and their fluctuations, use of steam through a back pressure turbine, and absolute necessity of continuous service. Boiler design, type and efficiency of steam-purifying equipment, composition of feedwater and details of feed treatment made practical an extraordinarily high boiler-water concentration. Steam purification, he emphasized, is essential in such a plant. The feedwater system must insure practically complete and continuous removal of scale-forming solids, and this must be supplemented by internal treatment. Its success depends on intelligent design of dosing equipment, proper locations for injecting chemicals, accurate dosage control, and frequent testing of water samples.

A R Stevenson and E E Parker of General Electric presented the only paper, "The Young Mechanical Engi-

neer in the Electrical Industry", at an evening session on personnel problems. They explained that large proportions of electrical manufacturing operations are mechanical, requiring design according to mechanical-engineering principles. This has caused GE to give graduate electrical engineers more fundamental training in mechanical principles and also to recruit more mechanical engineers.

In discussion, A M Dudley of Westinghouse agreed with their findings and said that there is too much prejudice among engineers against starting in the drafting room. He feels that universities should not reduce time spent in the drafting room, and that the shop as well as the design room offers a splendid opportunity for the technically trained man.

Power for Paper

R T Sternberg, superintendent of power for Hammermill Paper Co, in "Steam, Power and Water Distribution and Use in the Manufacture of Sulphite Paper", said that possible savings in transmission and application of the power services may be much greater than in generation. To obtain some of these, Hammermill first made complete diagrammatic layouts of all distribution systems, then inspected all these lines for leaks, defective insulation, unwise connections, etc. Some piping and valves were salvaged for use elsewhere and a rational basis for costing established, as well as many faults corrected.

In costing, all operations in paper manufacture were listed and the consumption of power services of each worked out. From these were set up annual quantities of steam, water and power per ton of paper. Something over 27% of steam goes to the sulphite mill, 64% to paper mills. 47.7% of all steam generated went to paper machines. Total consumption of steam per ton of finished paper is 26,145 lb. Electricity per ton is 622 kwhr, 26% to the pulp mill, 30% to the paper mill, the rest for general use.

In discussion, P W Swain, editor of *Power*, urged the desirability of determining a separate unit cost for each major power service and charging major departments for consumption on an actual, not an arbitrary, basis. S T Powell noted the difficulty of establishing a power cost-accounting system in a plant that had "grown like Topsy". In some such cases it pays to make radical piping changes and add meters to permit intelligent measuring and cost finding. Big organizations may find it advisable to revamp thus, then put one man in charge of electrical connections, another on water, still another on steam, to keep the systems straight.

L S Wilcoxson of Babcock & Wilcox spoke on "Burning of Waste Liquors in the Kraft and Soda Paper Industries." For years it has been customary to recover chemicals and some waste heat from these used liquors from the digesters. Mr Wilcoxson described in detail an advanced recovery-process unit, including boiler furnaces fired with "black liquor."

Luncheon and Dinner

At the Monday luncheon, President Herron reviewed early industrial history of Erie (his birthplace), mentioning pioneer work by Erie City Iron Works, Ball Engine Co, and Skinner Engine Co. President Herron also presided at the dinner meeting Tuesday night, at which A R Smith, managing engineer of the GE turbine department, spoke on "Wealth and Engineering". W L R Emmet of GE spoke on "Present Status of the Emmet Mercury Vapor Process of Power Generation". From the start, Dr Emmet has been the motive power behind mercury vapor development. The Hartford installation, he says, has been an unqualified success from the start, except the boiler. Since 1932, the plant has averaged 7,000 hours operation per year. Dr Emmet does not consider this job commercial, however, because of high maintenance cost and inaccessibility. Since his retirement he has concentrated on marine applications. He stressed the point that pioneer work cannot be done collectively; it must be done by one man. He announced that the experimental mercury-vapor plant at the Pittsfield GE works is now running all right after many troubles. Boiler circulation now is perfect.

Davis Elected ASME President

Shortly before the Erie meeting, the ASME announced the election of Harvey N Davis as its new president. Dr Davis, who is president of Stevens Institute and an outstanding participant in steam-table research and coordination, will assume office, with the other new officers on Dec 10, 1937, at the close of the annual meeting

Other ASME Officers

VICE-PRESIDENTS

F O Hoagland, master mechanic
Pratt & Whitney Div,
Niles Bement-Pond Co,
Hartford, Conn.

B M Brigman, dean
Speed Scientific School
University of Louisville,
Louisville, Ky.

Harte Cooke, mechanical engineer
McIntosh & Seymour Corp,
Auburn, N. Y.

W H McBryde, cons. engineer
San Francisco, Calif.

L W Wallace, direc. Div Eng. Rsch.
Association of Am Railroads,
Chicago, Ill.

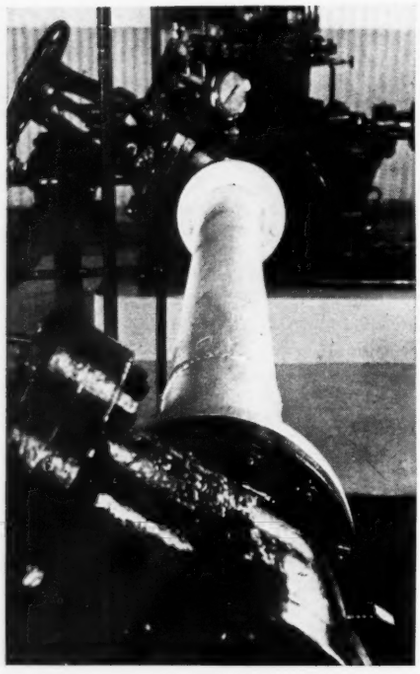
MANAGERS

Carl L Bausch, vice-president
Bausch & Lomb Optical Co,
Rochester, N. Y.

F H Prouty,
Prouty Brothers Engrg Co,
Denver, Colo.

S B Earle, dean, *School of Engineering*
Clemson A & M College, Clemson College, S. C.

PRACTICAL AIDS TO OPERATION



Causes of Vibration in High-Pressure Pumps

AN 8-stage centrifugal pump handling crude oil at a temperature of 350 F and pressure of 800 lb per sq in. began to vibrate after 13 months of 24-hour-per-day service without shut-down. When the pump was opened, the balance disk and shaft bearings were found worn. Replacing these parts reduced the vibration but did not completely eliminate it.

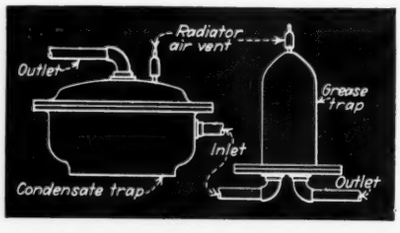
Checking the turbine failed to show any difficulty, but when the flexible coupling was dismantled and inspected, the trouble became apparent. Laminated disks had acquired a permanent set under driving strain that left them distorted. Under certain load and speed conditions, they acted as springs to set up pulsations, or surges in pump speed which, once started, magnified rapidly. New coupling parts completely removed the trouble, and the charging pump again ran smoothly. Since that discovery, it has been the rule to replace these coupling disks once each year to head off trouble before it can involve a greater replacement cost within the pump.

In another instance (handling cold crude oil under 3,000-lb-per-sq-in. pressure) two 4-stage centrifugal pumps in series functioned satisfactorily for nearly two years and then began to vibrate. Conditions rapidly grew worse until the pumps had to be shut down.

Investigation showed that the balance disk of No. 1 pump was badly worn. When replaced, it quickly worked out of adjustment a second time. It was finally discovered that the trouble was caused by the pipe connecting No. 1 discharge and No. 2 suction. The heavy section, carrying two gate valves and 12 ft of 6-in. pipe, was unsupported save at the two pumps, and as first installed was sufficiently rigid. In time, packing in the gate-valve flange joints yielded under alternate expansion and contraction stresses. Although the joints did not leak under pressure, the flange bolts were under considerably less tension than when installed. This slight amount of slack permitted the line to act as a resonator under certain conditions of pump speed and oil velocity.

After replacing the gaskets, a band was clamped around each flange joint, and a plastic gasket compound forced into the space between the flanges with a pressure grease gun to provide a wide face for dampening out vibrations. Since this work was completed no trouble has been experienced, even though the unit has operated for more than four years.

Longview, Texas ELTON STERRETT



Air Vent Corrects Trap Operation

LOW-PRESSURE traps on condensate return lines and oil traps connected to oil extractors on exhaust-piping of a heating system became air bound. This prevented flow of condensate from the heating system's return piping and of oil and emulsified substances from the oil extractor. Condensate backed up on heating surfaces, and oil accumulating in the oil extractors flowed through the piping systems.

Traps were provided with small pet cocks manually controlled for air relief. The operator's solution of the trouble was to leave pet cocks partially open which allowed steam to blow to atmosphere continuously. This caused steam losses, noisy operations, unreliable and improper heating-system performance.

Installation of common radiator thermostatic air-relief valve vents in place of the manually controlled air vents (see figure), corrected the defective trap performance and eliminated other objectionable features.

Chicago, Ill. T J BRETT

Extending Life of Pump Rods

WHEN a pump rod required frequent replacement because of scoring by the packing, the chief engineer utilized a small motor-driven air compressor as a means of truing the scored sections. He drilled and tapped the compressor-shaft end for a ½-in. bolt thread. A nut of the proper size to fit the crosshead end of the pump rod was welded to a threaded stud and the latter screwed into the compressor crankshaft. A bearing set into a block of wood at the proper height completed the equipment.

A damaged rod was then screwed into the socket attached to the compressor and supported in the outboard bearing, as in the figure. With the compressor running, the pump rod was revolved and the scored section trued up in a fraction of the time required for hand filing.

This method permitted each set of rods to be trued from 4 to 6 times before the section through the packing gland was reduced to the minimum diameter of the rod. Thus, rod life was increased proportionally. For the reduced rod sections, split junk rings were made, formed from heavy sheet copper to fit within the packing gland.

Philadelphia, Pa. B R THOMPSON

Repairing Scored Compressor Cylinders

SCORES in cylinder walls of an ammonia compressor may be satisfactorily repaired by filling in with ordinary solder. These compressors are made from a tough cast iron and I have never found it necessary to preheat the cylinder walls to prevent cracking. For heat, a No. 8 or No. 10 welding tip can be used with an acetylene torch and the scored sections brought to a temperature that will melt the solder when it is brought in contact with the cylinder wall. Zinc chloride or other suitable fluxes may be used to tin the scores. Excess solder may then be removed by a scraper or an old piston ring that conforms to the cylinder wall.

As excessive temperatures are not encountered with ordinary ammonia compression, a solder repair will last indefinitely and the cost will not be over about $5 for material, as compared to a high cost rebore job, depending on size of the compressor.

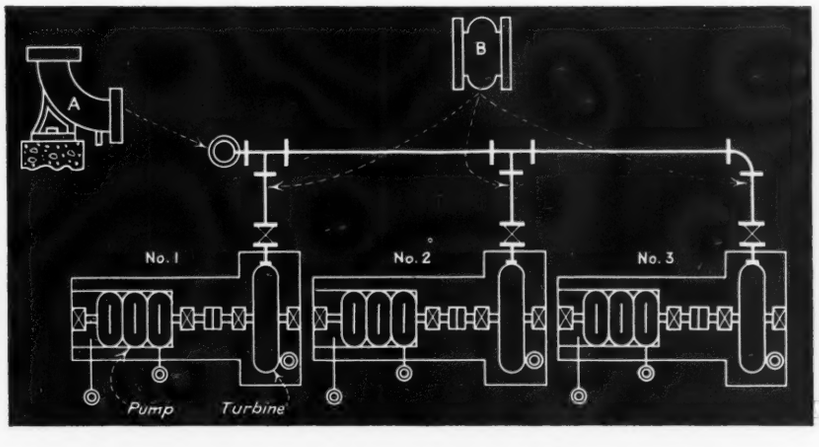
Scottsbluff, Neb. C A VAN DEURSEN

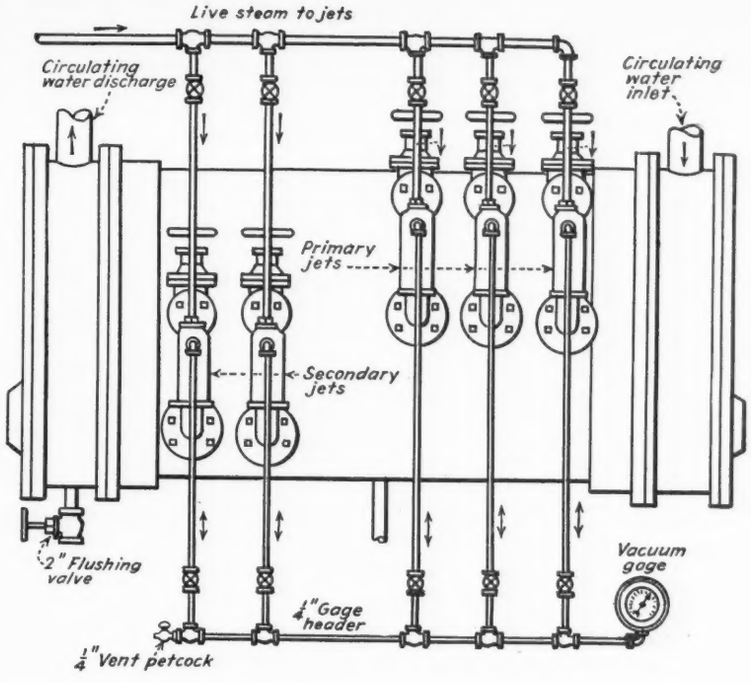
Steam-Pipe Expansion Causes Faulty Alignment

THE DIAGRAM shows the general arrangement of three steam-turbine-driven centrifugal pumps that gave trouble with hot bearings and vibration from the time they were first started. A 10-in. base elbow *A* in the exhaust line, to which each turbine connected, anchored the pipe at that point. From turbines to the main exhaust line, connections were short and rigid, comprising a valve and short length of pipe. In the plant were 4 other similar pumps that had operated satisfactorily for a long time; therefore it was apparent that the new pumps and turbines were all right, but that something was wrong in their installation.

A manufacturer's shop man was finally called in. Being suspicious of the piping arrangement, he loosened the coupling bolts on one unit and found that the pump and turbine were badly out of alignment. The turbine and pump were in good alignment when they and the piping were cold, but expansion of steam lines destroyed the alignment. The trouble was corrected by installing an expansion joint of the type shown at *B* in each exhaust connection, as indicated. This experience emphasizes the necessity for checking coupling alignment after the steam piping and equipment reaches operating temperature, if there is any indication of faulty operation.

New York, N. Y. C W PETERS





Checks Steam Jets With Vacuum Gage

EFFICIENCY of a steam-jet vacuum pump depends upon the vacuum produced. An operating engineer can tell if the jet is inoperative by the throat temperature, which should not be high, but he cannot tell if the jet is operating at its best efficiency, unless he has some means of determining the jet vacuum.

In one plant this was accomplished by direct readings. A 0.25-in. hole was drilled and tapped at a point just above the venturi. To save installing a number of vacuum gages, a $\frac{1}{4}$-in. valve was placed in the piping from each hole and all lines connected to a common header, as in the figure, to which the vacuum gage connected. A petcock was placed in the header to act as a vent.

To check operation of a jet, open the valve in the line to it. If the jet is operating properly, the vacuum gage will probably read about 29 in. Then, close the main steam valve to this same jet. If the jet is operating properly, the vacuum reading on the gage should drop about one inch. The first reading shows vacuum created by the steam jet, sufficient to draw vapor from the main condenser. The latter reading is vacuum existing in the main condenser. If the vacuum gage shows no appreciable change when the main steam valve is closed or opened, the jet orifice is evidently obstructed, and preventing proper steam flow. Obstructions are sometimes caused by loose scale or corrosive deposits.

When the orifice gives evidence of being closed, the steam valve to the jet should be closed. If the obstruction is loose, the main condenser vacuum will cause a backflow from the intercondenser, through the venturi into the precooler. This often clears the jet. Should the obstruction be lodged too solidly to be cleared in this manner, the jet must be disassembled and cleaned with a tool, taking care not to score or enlarge

the opening. A steel drill the same size as the original orifice will serve for this work.

When a jet is first put into operation, the vacuum-gage valve from that jet should be open. Then, as the main steam valve to the jet is opened, the vacuum gage should indicate an increased vacuum, because the steam jet produces a higher vacuum than that in the precooler and main condenser. Sometimes the jet casing will get hot, and the vacuum will not increase. In this case, open the petcock for a few seconds to admit cool air and to prime the jet. After the petcock is closed, vacuum should build up.

The opening in the venturi throat may grow larger, due to erosion and corrosion, and cause an increased flow of steam to produce the same vacuum. Unless steam supply to the jet is limited and under exact control and measurement, the vacuum gage will not show this condition. Periodic measurement of openings is advisable, as this is where waste of steam may occur.

Chicago, Ill. R O Billings

Clean Turbine-Oil Systems Regularly

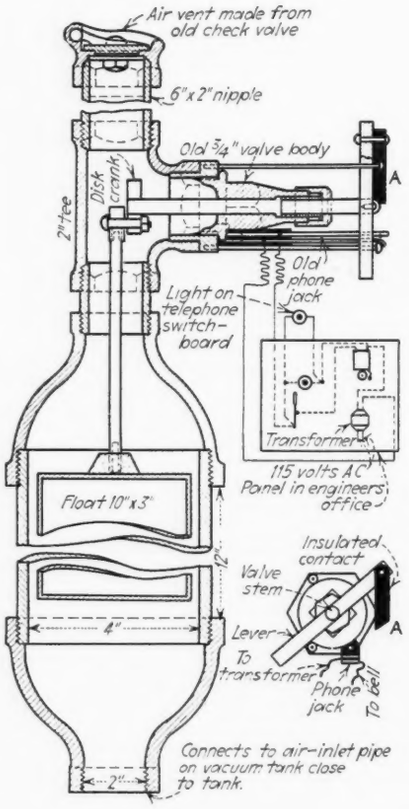
Modern refining methods developed from extensive research both in the laboratory and field have greatly increased the operating life of turbine lubricants. In general, if given proper care, turbine oil has an almost indefinite service life. The engineer, however, must remember that even though turbine oil has reached a high state of perfection, routine inspection and cleaning of oil systems is still necessary. Solid material, for which the lubricant is in no way responsible, may enter the system and cause operating difficulties. While the introduction of foreign matter when adding makeup oil, through oil-ring inspection openings or at other points where the lubricant is exposed, can be prevented by using reasonable care, dirt often originates on the inside of the system itself.

This internal dirt may be pieces of gasket, particles of bearing metal, scale from metal surfaces, gasket compounds, shavings from improperly reamed pipe or pellets breaking away from welded joints. All of these sources have been known to cause trouble. In fact, only recently a piece of mill scale in the inlet oil line of a large industrial turbine bearing so reduced the oil flow that it was necessary to remove the unit from service to save the bearing.

Electrolytic action caused by circulating currents in the shafts of generators is another source of oil-system deposits. Outboard bearing pedestals are insulated from their bed plates to avoid completing a circuit for these currents, and unless this insulation is maintained, trouble both with sludge material thrown down by the oil and pitting of the bearing metal will often be experienced.

To insure continuity of operation and to avoid expensive maintenance, turbine-oil systems should be inspected and cleaned at least once a year and oftener if much foreign matter is found, until the cause of its introduction is discovered and eliminated. Needless to say, every care must be used to prevent dirt entering the system while inspecting or maintaining the turbine.

St. Louis, Mo. O C Miles



High-Water Alarm for Vacuum Tank

If a vacuum pump failed to start in our plant, it might not be discovered until condensate had backed up into the heating system and caused low water in the boiler. As there was no low-water alarm, I made one to go onto the vacuum tank. The device comprises a float-operated electrical contact connected to a bell and two signal lights.

The float chamber is a section of 4-in. pipe with a 4-to-2-in. reducer on each end. A 2-in. tee connects to the top end of the float chamber by a short nipple. Into the tee is threaded a bushing to support an old valve body with a short crank on the inner end of the stem, to which the float connects. To prevent air binding in the float chamber, a vent made from an old check valve closes the top end of a 6-in. nipple threaded into the tee.

The electrical part of the system is an old telephone jack mounted on the valve body and arranged so that the contacts are closed by an arm and insulated contact carried in the valve stem at *A*. Jack contacts connect to a bell-ringing transformer, bell and two lights. One light and the bell is on the engineer's signal board and the other light is on the telephone operator's switchboard. The latter is for night when the attendant may not be in the basement. If the telephone operator sees the light flash and remain burning, he calls the watchman.

A single-pole knife switch in the bell circuit allows the attendant to stop the bell ringing, but the lights remain lighted until water returns to normal level. As long as condensate in the vacuum system remains below a predetermined level, the jack contacts are open. Failure of the pump permits water to rise in the float chamber, upward motion of the float rotates the valve stem to close the contacts and give an alarm.

New York, N. Y. A Honore
Hotel Whitehall

Cleaning Out Stoker Gear Boxes

Before gear boxes of stokers and other power-plant equipment are disassembled for inspection or maintenance, oil and grease must be drained from the cases. Gear lubricants, however, are usually viscous and cling tenaciously to the internal surfaces of the gear assembly so that it is ordinarily impossible to effect complete removal by drainage alone. Using a supplementary method of cleaning these surfaces before tearing down the gear box will avoid time, labor and mess incidental to cleaning each individual part as it is removed. In one large boiler plant having a number of such gear boxes, the following cleaning procedure has proved effective:

1. Drain all lubricant from the gear case that will flow at room temperature. This oil may be saved or discarded depending upon its condition.

2. Heat the gear case directly with steam to reduce the viscosity of the remaining lubricant. Leave the drain valve open until oil flow ceases. This mixture of lubricant and water must be discarded.

3. Close the drain valve, partly fill the casing with water and bring to a boil with the steam. Add to the boiling water 2 lb of soda ash and 2 lb of trisodium phosphate or, if available, some commercial alkaline grease solvent.

4. Continue boiling for 30 min, adding water occasionally so that any floating lubricant will overflow into a drain or receptacle.

5. Drain off the cleaning solution and wash the gear case with hot clear water.

Roanoke, Va. S H COLEMAN

Making Boiler Inspections

AT REGULAR intervals, boiler inspectors visit plants to make external inspections. Some chief engineers take little interest in this inspection, being content to sit at their desks, or go about other duties. This is poor practice; the chief engineer or a competent assistant should perform this routine inspection every day the plant operates.

On such inspections, test condition of the water columns and gage glasses. Operate drain valves and thoroughly blow down connections. Observe action of water returning to the glasses to check possibility of an obstructed connection. Try gage cocks to be sure that they are free, and to check water level indicated by the glasses.

Lift safety-valve levers to guard against freezing or accumulation of deposits. If safety valves do not blow at least once a week, raise the boiler pressure to the value for which the valves are adjusted. Check the pressure observed on the gage with that at which the safety valves blow.

At least twice a year check accuracy of the pressure gage by comparing it with a standard test gage. Provide a ¼-in. valved branch connection in the gage line for this purpose. If this connection is not at the lowest part of the pressure-gage piping, provide a drain cock so that any sediment in the line can be blown out periodically. Take care not to blow the water out of the syphon leg when the boiler is under steam pressure, or the gage may be overheated and damaged.

Examine all accessible parts of the boiler plant for leaks. Leaks should be traced to their source and stopped, for they are costly and may be a warning of a dangerous condition.

After checking water level in the boilers, open blowdown valves long enough to show that the line is clear, and to remove any sludge or sediment. It is well to impress upon the operator the dangers of water hammer if blowdown valves are manipulated carelessly or too quickly.

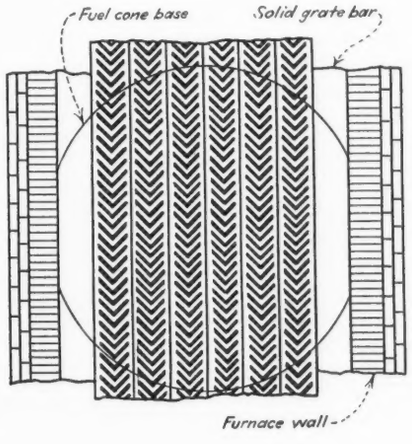
Cleanliness and neatness of the boiler room are essential. A dirty, cluttered-up plant is an invariable indication of careless personnel. Accident prevention starts with good housekeeping in the power plant.

Open the fire and cleanout doors to permit examination of fire surfaces so far as possible. Look for bulges or blisters on tubes or boiler shell. These conditions generally necessitate immediate shutting down of the boiler. Note condition of the baffles. Broken baffles allow high-temperature gas to short-circuit part of the passes and cause poor efficiency.

Check condition of the brickwork, sidewalls, arches, etc. Many accidents result from these sources. Try the main stop valves to determine if they are jammed open. Loss of a few seconds to free a jammed valve is a serious matter in time of emergency.

Give attention to anchors, supports, drains, and expansion points of the steam piping. Slight settling of foundations or building members may cause an unequal and serious strain on the steam piping. Settling of piping itself may present the additional hazard of low points in which water pockets form.

Cleveland, O. A C WIGGINS

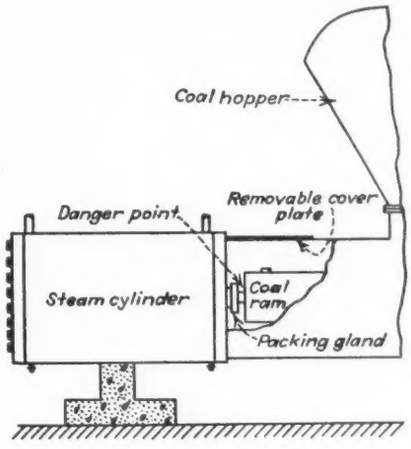


Reducing Erosion of Furnace Brickwork

FUEL, shavings and sawdust fall in a steady stream through the top of a Dutch oven on our boiler, and build up into a cone. The cone base flattened against furnace sidewalls for a short distance on each side at midgrate length. This produced an intense flame impingement against the furnace walls at these points, causing the firebrick to be cut away rapidly, small sections of which had to be rebuilt frequently.

To reduce flame effects on the furnace walls, I had the outside grate bars cast solid (as in the figure). The use of these bars about doubled the life of the brickwork. To get some idea of how effective the solid bars would be before having them made, I operated the furnace for a while with the grate bars along the sidewalls covered with firebrick.

Vancouver, B. C. R MANLEY ORR

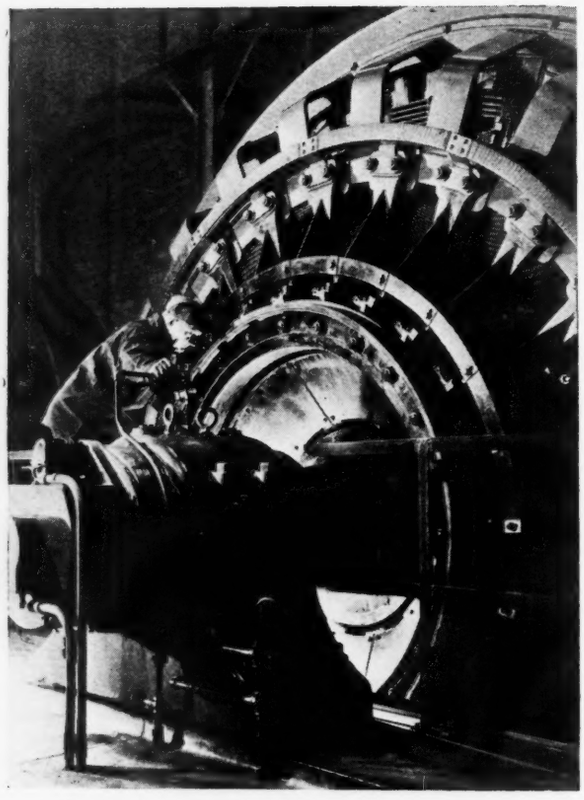


The Case of The Missing Hand

EXCESSIVE leakage from the stuffing-box of an automatic steam cylinder (of a type in which the coal plunger head comes out to within less than 0.5 in. of the packing gland on the loading stroke) came to the attention of a fireman. When opportunity came to shut down the stoker for a few minutes, he closed the steam valve when the coal ram was close to the end of its delivery stroke. Contrary to previous instructions, he forgot to open the drips, put his hand down to feel the packing-gland adjustment and reached for a wrench with the other hand. In the instant that his eyes were on the nearby wrench, the coal ram kicked back and pinned his hand against the packing gland. When he was freed and rushed to a hospital, the bones were crushed so badly that amputation was necessary.

The coal ram moves slowly on its inward, delivery stroke, but returns rapidly. When steam is shut off at about the end of the ram stroke, some cushioning steam is compressed ahead of the piston. Unless the drips are opened to bleed this pressure, there is always danger of the coal ram kicking back. It is certainly no place for one's hand in front of this piston, and power-plant operators should always remember to open drips for at least a minute before working in or near the plunger rod.

Flushing, N. Y. H M SPRING



5,000 HORSES

One of four 5,000-hp, 110/250 rpm, 600-volt, dc motors that drive 100-in. semi-continuous sheared plate mills in a Pittsburgh steel mill —*Allis-Chalmers Photo*

POWER LINES

Utility and Oil Co Swap Services

Pacific Gas & Electric Co, San Francisco, and the Tidewater-Associated Oil Co have entered into an agreement whereby PG&E will build on the oil company's property at Avon, Cal., a 35,000-kw steam-generating plant to cost $5,000,000.

As in the town where everybody took in each other's washing, the plan provides for an interchange of services and materials between the two companies. Under the contract, the oil concern sells petroleum sludge, fuel oil, and other combustibles to the electric company to burn in the plant, and the electric company provides electric energy and steam to the oil refinery.

Observers see the arrangement significant as the possible beginning of a trend toward construction by electric utilities of steam-generating plants for industrial concerns having low-pressure steam requirements. Other process industries on the coast where similar contractual relations might be made with the utilities include the pulp and paper mills and sugar refineries.

Construction of the new plant was brought about by the electrification and expansion program of the Tidewater-Associated Co at Avon which will about double its connected load. The oil concern's demand for energy will reach 8,000 kw, leaving the PG&E with considerable capacity to feed into its own transmission system. Service to the refinery will be at 2,300 volts, stepped down from the generating voltage of 12,000.

The electric company will install one turbine, which will take steam at 1,500 lb and 925 F from three boilers, each with a capacity of 200,000 lb per hr. Steam will be bled from the turbine for delivery to the refinery at 160 lb and 50 F superheat.

Cost of the installation, to be borne by the utility, is estimated at $5,000,000.

Hydro Plants Scheduled for California, Wisconsin

Wisconsin Public Service Corp announced in late September that it proposed to build a $1,500,000 hydroelectric plant on the Wisconsin River, midway between Merrill and Tomahawk below the company's present Grandfather Falls plant.

Application for approval to construct the plant is to be filed soon with the Wisconsin Public Service Commission. The proposed plant will have a capacity of approximately 17,500 kw. Wisconsin Public Service this year is adding approximately 5,000 kw to its generating capacity with the construction of a new $500,000 plant at Tomahawk.

In California, the Sacramento Municipal Utility District, Sacramento, has filed application with the Federal Power Commission for a preliminary permit to construct a 201,000-hp hydroelectric project in Eldorado County, California, on Silver Creek and the South Fork of the American River.

The District proposes the construction of the development in two steps, the first to consist of two storage reservoirs connected by a tunnel, a diversion dam, a conduit, and a power house, to be known as the Brush Creek development, which will have an installed capacity of approximately 50,000 hp. Ultimate development of the project will enlarge the two storage reservoirs, and construct two additional diversion conduits and two additional power plants, to be known respectively as the Big Bend and Chili Bar plants, which will raise the total installed capacity to an aggregate of 201,000 hp.

Battersea Will Add 100,000 Kw to Capacity

The London Power Company announces in *The Engineer* that approval has been given for the extension of Battersea Station. The first half of the station now in operation at 600 lb, 850 F has a total capacity of 243,000 kw. The second half of the station will operate at 1350 lb, 950 F with stoker-fired steam-generating units. The straight regenerative cycle will be used with six stages of feedwater heating to 400 F.

The new unit will add 100,000 kw to the station capacity made up of a 16,000-kw, 3000-rpm high-pressure turbine and an 84,000-kw, 2-cyl, 1500-rpm low-pressure section operating at 600 lb. Two 500,000-lb-per-hr boilers will have unusually large furnaces for low heat-release rates. The flue-gas washing plant will follow the general lines of that already found successful in the first half of the station, but will have a number of minor improvements incorporated based on experience obtained.

Steam Plants Proposed for New York and Kansas

Construction of a 115,000-hp steam plant, to cost about $10,000,000, is to be undertaken in the near future by Niagara Hudson Public Service Corp (now renamed Central New York Power Corp), at a site in central New York.

The definite site of the plant has been selected at Oswego, although three sites had been considered, one at Oswego, another on the Racquette River, and the other on the Hudson River just south of Albany.

Kansas Gas & Electric has announced plans to build a 20,000-kw steam plant to add to the capacity of two plants already in operation in eastern Kansas. The new plant will be located at the north edge of Wichita, and a contract with the Phoenix Engrg Corp, New York, N. Y., calls for completion of the plant by August, 1938.

The plant will contain a single 20,000-kw unit, to be tied in with the Wichita plant, which has two 10,000-kw and one 6,000-kw units, and the Neosho plant, consisting of one 20,000-kw and one 15,000-kw unit, located at Parsons, Kan.

Chemical Industries Show In New York, Dec 6-11

Display plans for the 16th Exposition of Chemical Industries are being rapidly advanced by the more than 250 exhibitors who have engaged space to date. Three floors of Grand Central Palace in New York, N. Y., will be occupied, and indications point to one of the most successful Chemical Expositions in the long history of these events. Raw materials and chemical products, laboratory and plant equipment, and the machinery essential to manufacturing in all of the industries based on chemistry and chemical engineering will be shown at the Exposition. It will be held during the week of Dec 6 to 11.

Included in the equipment exhibits will be electric motors adapted to many specialized industries. In addition to the usual open models, there will be explosion-proof, dust-proof, and splash-proof motors. There will be a new line of oil-immersed, explosion-proof, and corrosion-resisting combination line starters. These line starters constitute a new development to meet demands of the chemical industry for a reliable starter and disconnect switch of sufficient rupturing capacity for short-circuit protection. The starter is mounted in a unit enclosure under oil.

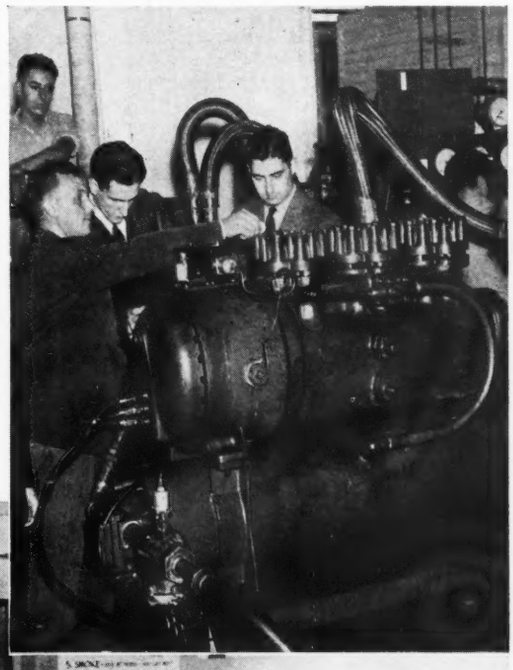
Pumping and pipeline equipment of great variety will be on display, including acid-proof pumps and exhausters featuring chemical stoneware as the material of construction. Stainless steels, resistant to weak sulphuric acid, and high-silicon iron, resistant to hydrochloric acid, will be among the metals featured for pump, valve and pipeline construction. An innovation at the Exposition this year will be pumps and valves made entirely of glass. To withstand corrosive action of acids under high pressures and temperature, lead-lined pipe, fittings, valves, coils, and tanks will be shown, as well as antimonial lead pipe, fittings, and valves.

The 16th Exposition of Chemical Industries is to be held under the direction of Charles F Roth. Mr. Roth, who is president of the International Exposition Company, has directed each Chemical Exposition since the first one was organized in 1915. Permanent headquarters of the management are at Grand Central Palace, New York, N. Y.

ENGINEERS AT WORK

***Right*—No theory here, as students at Westinghouse's air-conditioning school watch a hermetically-sealed condensing unit go through its paces on the test floor of the company's East Springfield, Mass., works.**

Below—With coats off, 70 engineers take in knowledge at the Westinghouse air-conditioning application school held in East Springfield, Mass., Oct 4-29. These students were sent in by Westinghouse distributor organizations throughout the U.S. and foreign countries for 4 weeks postgraduate work in advanced principles of application



Russia Starts Work on Huge Hydro Station

Construction of Russia's largest power station (it is ultimately to be the largest in the world) was given official approval late in September by Soviet officials. The station, a hydro plant on the Volga River, will be the biggest project of the Third 5-Year plan and the most spectacular single detail in Stalin's plan to remake Russia. Construction of a workers' village at the dam site has been started.

The plan calls for a concrete dam 1.8 miles wide across the Volga, which will raise the river approximately 300 ft. The proposed hydroelectric station will have a capacity of 2,500,000 kw (compared to 1,900,000 kw projected capacity of the Grand Coulee on the Columbia River). Besides generation of power, the dam is expected to furnish water for reclaiming millions of acres of the Soviet's black soil belt, now impoverished by recurrent drought.

Welding Society Medal Goes to H S Smith

The Samuel Wylie Miller Medal, an annual award of the American Welding Society presented for meritorious contributions to the science and art of welding, has been awarded to H Sidney Smith. Well-known in the acetylene industry both in America and abroad, Mr. Smith has served as president of both the British Acetylene Assn and the International Acetylene Assn and has been directly responsible for many important developments in acetylene utilization.

Elected president of the International Acetylene Assn in 1920 and president of the Compressed Gas Manufacturers Assn in 1928, Mr. Smith also has been for many years a director and a member of the Executive Committee of the American Welding Society. He is also a member of the ASME, the ASTM, the National Fire Protection Assn, The National Safety Council, The American Society of Safety Engineers, and a number of other engineering groups.

Progress at Delray and Conners Creek

At Delray Station of Detroit Edison, necessary alterations to steel framing on the pipe gallery floor and walkways in Power House No. 3 have been completed. Mezzanine and operating-floor construction in the boiler house is about 95% complete, and exterior brickwork for this section of the building has been started. The brick wall between the auxiliary bay and the boiler house is complete, and the turbine room is completely bricked up

Concrete has been poured for the base of 75,000-kw turbine No. 14, and the installation of steel sash and copper spandrels in the turbine house has been started. Tube piling for platforms supporting 100,000-kva transformers for Nos. 14 and 15 main units has been

AT THE AISEE POWER EXHIBIT

Approximately 140 power-plant and steel-mill equipment manufacturers occupied space at the exposition sponsored by the Assn. of Iron & Steel Electrical Engineers, held simultaneously with the convention, Sept. 28 to Oct. 1, Stevens Hotel, Chicago, Ill.

driven and excavation and formwork for No. 14 platform is being started. These platforms are reinforced concrete structures approximately 25x22x11 ft deep adjoining the east wall of the turbine room, built on 12 welded-steel tubes, diameter 12 and 14 in., average length 83 ft, the space between the floor and roof slabs serving as cable compartments.

Work on the installation of new boiler No. 10 at Conners Creek Plant is well advanced. The hydrostatic test has been completed, and the boiler will be ready for the drying fire about November 1. Removal of old boiler No. 9 has been completed, and the erection of supporting steel-work in this space for new high-pressure boiler No. 9 has been started. Drums for this boiler are scheduled for delivery January 5, 1938. Changes necessary for the operation of 45,000-kw turbine No. 4 as a spare unit from high-pressure boilers, including the installation of desuperheating and pressure-reducing equipment, new boiler-feed and hotwell pumps, new feedwater heaters and heater drains pump, are scheduled for completion November 15.

Power Applications Features AISEE Convention

(*Continued from page 695*)

varied as the manufacturing industry itself. The technical and practical education of the test engineers, together with their experience, backed up by a good store of common sense, will enable them to be of great service to their company.

Other papers of interest to power engineers include, "Layout and Installation of Low-Voltage DC and AC Systems in Steel Plants," by Donald Nelson, assistant electrical engineer, Jones & Laughlin Steel Corp; "Surges and Their Effect on Transformers," by H Weichsel, consulting engineer, Wagner Electric Corp; "Design and Operation of New Boiler House—Ohio Works, Carnegie-Illinois Steel Corp," by C H Williams, assistant chief engineer, Carnegie-Illinois Steel Corp; "Organization and Functions of a Steel Plant Maintenance Department," by T E Hughes, superintendent of maintenance, and J J Booth, assistant superintendent of maintenance Carnegie-Illinois Steel Corp; "Progress of Welding in 1936 and 1937," by G A Hughes, chief electrical engineer, Truscon Steel Co; Welding Economies and Application," by E W P Smith, consulting engineer, Lincoln Electric Co; "The Development and Application of Covered-Electrode Arc Welding," by A M Candy, consulting engineer, Hollup Corp; and Alternating-Current Arc-Welding Advances," by C J Holslag, Electric Arc Cutting & Welding Co.

PERSONALS

FREDERICK D BENZ, formerly manager of Wire Sales, Chicago Branch, U S Rubber Products, Inc, has been appointed district manager of Wire Sales, Pacific Div, for the same company, with headquarters at San Francisco.

F M MAICHLE has been named manager of Lincoln Electric Co's Detroit sales-engineering office, 10228 Woodward Ave.

JOHN T COTTER, manager of the Freeport, N.Y., municipal power plant, retired on Oct 1 after 40 years of continuous service. During the past ten years he has been manager. His successor is Thomas Dunn, who has served at Freeport for the past eight years.

H MCE PATTON has joined the staff of the Research and Development Div of Jones & Laughlin Steel Corp, Pittsburgh, Pa.

WILLIAM C CARTER and Edward J Burnell were recently elected vice-presidents of Link-Belt Co, Chicago, Ill.

JAMES M KOBABE has joined Lee B Mettler Co, Los Angeles, Calif., as executive general manager. Mr. Kobabe has been affiliated with the Mettler Co dur-

MEETINGS

American Society of Heating & Ventilating Engineers—*Annual Meeting, Jan 24–28, Biltmore Hotel, New York, N. Y. A V Hutchinson, secretary, 51 Madison Ave., New York, N. Y. Concurrently with the meeting will be held the 5th International Exposition of Heating, Ventilating and Air Conditioning at the Grand Central Palace, New York, N. Y., Charles F Roth, manager.*

American Society of Mechanical Engineers—*Annual Meeting, Dec 6–10, Engineering Societies Bldg, New York, N. Y. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Society of Refrigerating Engineers—*Annual meeting, Jan 26–28, Roosevelt Hotel, New York, N. Y. David L Fiske, secretary, 37 W 39th St, New York, N. Y.*

Chemical Industries—*Sixteenth Exposition, Dec 6–11, New York, N. Y. Charles F Roth, International Exposition Co, Grand Central Palace, New York, N. Y.*

Drying and Air-Conditioning Symposium—*Dec 27–28, University of Pennsylvania, Philadelphia, Pa. Under auspices of Div of Industrial and Engineering Chemistry, American Chemical Society. Symposium chairman, D B Keyes, Dept of Chemistry, University of Illinois, Urbana, Ill.*

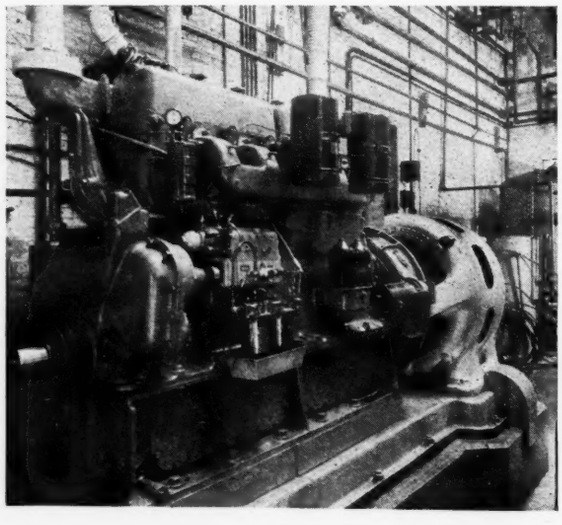
International Acetylene Association—*38th Annual Convention, Nov 10–12, Birmingham, Ala., Hotel Tutwiler, Assn headquarters, 30 E. 42nd St, New York, N. Y.*

National Warm Air Heating and Air-Conditioning Association — *Winter convention, Jan 24–26, Roosevelt Hotel, New York, N. Y. Allen A Williams, managing director, 50 W Broad St, Columbus, Ohio.*

Refrigeration Service Engineer's Society—*Annual convention and exhibit, Nov 3–5, Hotel Stevens, Chicago, Ill. Herman Goldberg, chairman, 9 S Clinton St, Chicago.*

SPARK IGNITED

THIS 6-cyl., 7x7-in., Waukesha-Hesselman spark-ignition oil engine, direct-connected to a Crocker-Wheeler generator, develops 125 to 150 hp. and operates about 40 hrs. a week in a large city laundry. Lubricating oil is centrifuged continuously. Fuel cost, for about 25% more load than that for which power was formerly purchased, is $154 (2,200 gal.), while purchased power cost $700. Depreciation, insurance, and similar capital costs are not considered in this comparison, and would reduce the saving somewhat



ing the past 11 years as direct factory engineer, with general distributorship of Mettler products in the Middle-West.

M F MAY has been appointed vice-president of Young Radiator Co, Racine, Wis. Mr. May has been connected with Young Radiator Co since 1930, and since 1933 has been sales manager of the Catalog Products Div.

RAYMOND R TUCKER, former secretary to Mayor Dickman, has been appointed smoke commissioner of St. Louis, Mo. Selection of eight smoke inspectors to operate under Mr. Tucker is now under way.

RALPH L WILSON, formerly metallurgical engineer of the Steel and Tube Div, Timken Roller Bearing Co, has joined the Climax Molybdenum Co in the same capacity.

R D MCMANIGAL has been promoted to the position of manager of the Central Station and Transportation Div of Westinghouse Electric International Co. Mr. McManigal joined Westinghouse in 1915, seven years later went to Japan as railway specialist, returning to New York in 1931 as assistant to manager of Central Station and Transportation Div.

Other Westinghouse International personnel appointments include D C Brooks, to sales promotion manager, H S Reizenstein, contract manager, and G Blocksidge, assistant to vice-president.

CECIL E WHITE, formerly sales promoter for the Milwaukee division of Standard Oil Co, has joined the sales staff of Waukesha Motor Co's Gas Power Div.

L W BROWNE, formerly president of Fisher Governor Co, is now associated with O C Keckley Co, Chicago, as vice-president in charge of sales and distribution of their steam and liquid-control equipment.

FRANK W RANDALL, assistant general manager of New Hampshire Gas & Electric Co, Portsmouth, N. H., has been transferred to the New England Gas & Electric Co, Cambridge, Mass., as assistant to vice-president.

CARLTON L DUDLEY has been named Southern Div superintendent of Public Service Electric and Gas Co (New Jersey), succeeding Theodore B Morgan, who died Sept. 25. Clyde L Catham succeeds Mr. Dudley as assistant distribution engineer in the general offices.

PROF A G CHRISTIE, of Johns Hopkins University, Baltimore, Md., returned recently from a summer in England spent as consultant on power problems with British interests.

ALEXANDER W. LIMONT, JR has been appointed manager of the Compressor Div of Sullivan Machinery Co, Michigan City, Ind. Mr. Limont was previously connected with Norwalk Iron Works, Norwalk, Conn., as chief engineer, later with Ingersoll Rand Co, and with E I duPont de Nemours organization, with whom he has been associated for the past 9 years.

BUSINESS ITEMS

KENNEDY VALVE MFG CO, Elmira, N. Y., has appointed Fred C Graves as representative for the states of Oregon and Washington, with offices at 401 Polson Bldg, Seattle, Wash.

LINDE AIR PRODUCTS CO, New York, N. Y., has opened a branch office at 729 N Pennsylvania Ave, Indianapolis, Ind. Also, its Boston district office has been moved to 441 Stuart St, Boston, Mass.

HANCOCK VALVE DIV, Manning, Maxwell & Moore, Inc., Bridgeport, Conn., has added Charles Velie and Raymond Heath to its field sales staff. Mr. Velie will be located in Chicago, and Mr. Heath will make his headquarters in Dallas, Texas.

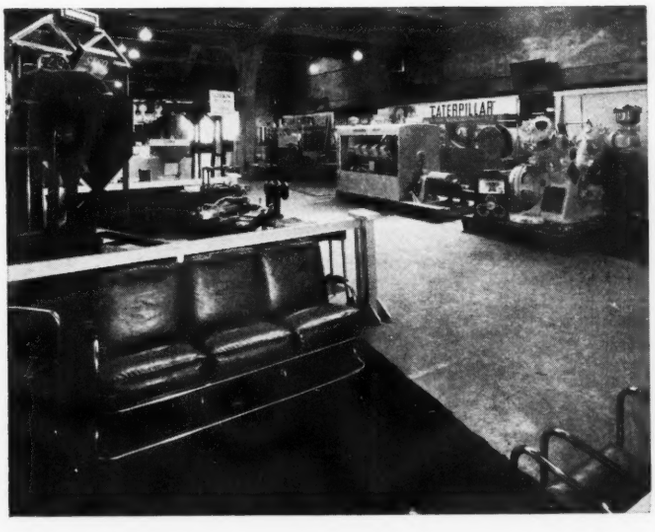
BIFLEX PISTON, INC, was recently incorporated with offices at 11 Broadway, New York, N. Y. The company was formed by William H Friend, former World War aviator and corporation lawyer, to license manufacturers of aviation engines, tractors, compressors and diesels, under Biflex Piston patents. The piston is said to reduce cylinder-liner wear, piston slap, and contamination of lubricating oil.

C. H. SPRAGUE & SON CO, Boston, Mass., has elected Walter J Ott as vice-president, and appointed Carlton R. Mabley, Jr, general manager, and Edwin H Schmits, sales manager.

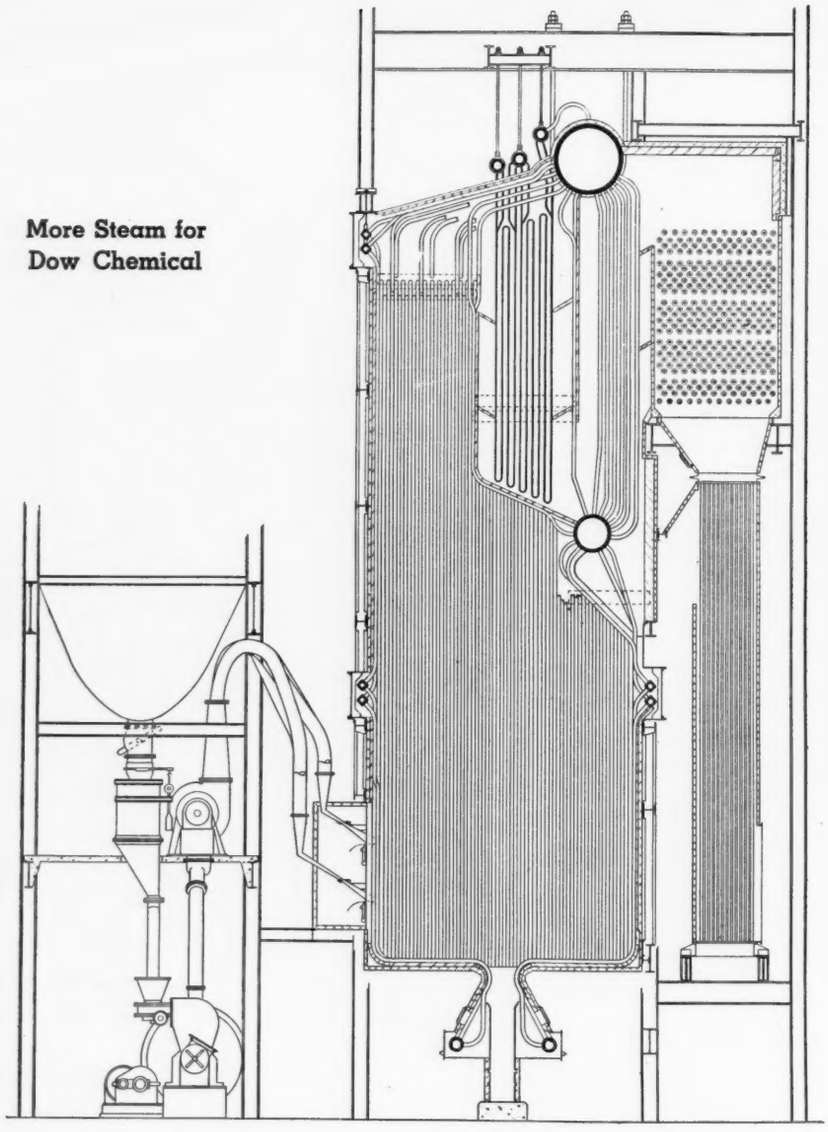
CUTLER-HAMMER INC, Milwaukee, Wis., has appointed A R Johnson manager of Merchandising Sales Div. E F Weiss succeeds Mr. Johnson as manager of the Detroit office. W E Ragsdale has been named manager of Cutler-Hammer's recently opened office in Dallas, Tex. E T Rees has been appointed manager of the branch sales office in Indianapolis. Also, the company has opened a new branch office at 625 NW Everett St, Portland, Ore, with F J Woldrich as manager.

The Camera at Chicago's Power Show

153 manufacturers (see story on page 694) exhibited mechanical-power-transmission equipment, motors and controllers, air compressors, diesels, boiler-furnace refractories, heat insulation, stokers, traps, valves and pipe fittings, lubricants and lubricating devices.



More Steam for Dow Chemical



Base steam load will be met by the continuous operation, at full capacity, of a 300,000-lb-per-hr, 1,400-lb, 850-F Foster Wheeler boiler now under construction at Midland, Mich. Intertube burners for pulverized coal are set in a 15,200-cu ft continuous-slagging furnace, with tubes on roof, floor, and all four sidewalls. Bypassing gas past the self-supporting multiple-loop superheater controls steam temperature. An exceptionally large economizer (27,800 sq ft) is required to raise the relatively cold feedwater from 220 F to 530 F. Locating the fans and drives on the operating floor makes it possible to install the 49,900-sq ft air heater below the economizer. The cross-section shows the compact layout that is the result of these location changes.

READERS' PROBLEMS

QUESTIONS for Our Readers

Simple Trap Test

Question 1

WE HAVE *been looking for years for a simple method of testing thermostatic steam traps without removing them from the line. When a trap is suspected of blowing steam, we would like to be able to check it without going to all the trouble of dismantling the line and putting the trap on a test rack. Perhaps some* POWER *readers have devised simple and sound ways of doing this. If they have, we'd like to know about such methods to simplify our present involved procedure.*—JES

Condenser Cleaning

Question 2

WE HAVE *been using rubber plugs for condenser cleaning for many years and have been getting fair vacuum results and tubes last eight or nine years. Recently we have been trying a steel scraper plug which gets the tubes cleaner but seems to scratch the tubes. Do* POWER *readers know of anyone who has used these plugs long enough to be able to say how much oftener we will have to replace condenser tubes if we use the steel plugs every couple of weeks.*—MCC

Suitable answers from readers will be paid for if space is available for publication.

SIZE OF BLOWDOWN TANKS

Answer to Sept Question 1

The Question

DO POWER *readers know of a rule that will determine definitely the proper size of a blowdown tank for high- and low-pressure boilers? I have looked through existing textbooks, but find nothing but good advice.*—GHH

First Check Code Requirements

THE PROBLEM to be solved by the installation of a boiler blowdown tank is that of wasting water which has been at high pressure and high pressure into a sewer line. Since sewer lines are at atmospheric pressure, some of this water will flash into steam if no separating chamber is provided. The presence of steam in a sewer line is very undesirable, and some authorities on sewer work consider very hot water to be a source of danger. As a result, laws governing the installation of blowdown tanks are in force in a great many places. This makes the first rule for the sizing of blowdown tanks: Investigate the municipal, county, and state codes for any rulings they may have in this regard.

In the event no law exists in a given place for a given condition of pressure and temperature, the following table may be of value:

Pressure lb. per sq. in.	Boiler Horsepower	Tank size Inches
1 to 11	1 to 11	16 x 20
11 to 16	11 to 26	18 x 24
16 to 26	11 to 26	24 x 30
16 to 26	26 to 51	24 x 36
26 to 51	26 to 51	30 x 36
26 to 51	51 to 76	30 x 60
51 to 76	76 to 101	36 x 48
76 to 101	101 to 126	42 x 60
101 to 126	126 to 151	42 x 72
126 to 151	151 to 201	48 x 72
151 to 201	201 to 301	60 x 60
201 to 301	301 to 401	60 x 72

In general, the drain tappings should be 4 in. in all cases with a suitable trap provided; vent tappings should be 4 in. in all cases, unless possible exception may be made of the two or three smaller tanks, when 3 in. may be used; blow-

down-inlet tappings should be the same size as the boiler blowdown nozzle. In the matter of connecting the blowdown line into the tank, some engineers deem it advisable to make the incoming water enter tangentially in order to reduce the velocity, while others call for a radial connection or even drop into the head of the tank.

In comparison with the above data, one state code reads as follows (abridged):

"The blowdown pipe discharging into a tank shall have a free discharge at least 6 in. above the maximum water level. The discharge connection shall be at least 24 in. below the top of the tank and shall be trapped with a water seal at least 24 in. deep. The minimum diameter of the tank shall be 36 in."

Using this code means that the minimum tank size would be 36 in. in diameter by 54 in. high, which gives us the following table:

Boiler Horsepower	Tank Size in.	Outlet Size in.	Vent Size in.
1 to 101	36 x 54	5	4
101 to 151	36 x 54	5	5
151 to 251	36 x 60	5	5
251 to 601	42 x 60	5	6
Over 600	48 x 72	6	6

In viewing the above two codes, it may be seen that there are conflicting opinions regarding the sizing of blowdown tanks. And usually for every code there is a different opinion.

All of which makes the problem of sizing blowdown tanks resolve itself into one where, if no ordinance exists, the engineer must rely on his own good judgment and experience, or that of others if available.

Richmond, Va. R P HANKINS

REMOVING OIL FROM PIPE SYSTEMS

Answer to Sept Question 2

The Question

WE *have been operating a steam-engine plant exhausting into a low-pressure steam distributing system for heating and other purposes. Oil in the engine exhaust has made itself apparent in the low-pressure steam piping. In a few months we will put into service a 500 lb plant, the turbine of which will exhaust into the old low-pressure distribution system. We want to use the condensate returns from this system as feedwater in the high-pressure boiler. Before doing so, it is necessary to make sure that piping is free from oil to avoid getting any of it into the high-pressure boiler. Have any* POWER *readers had experience with this sort of thing? The old engine plant is to be scrapped.*—HG

Several Methods for Removing Oil Deposits

REMOVAL of engine-oil deposits from exhaust-steam distribution systems can be accomplished in a number of different ways. Before using any method of cleaning, much of the deposit can be taken out by thoroughly blowing out the lines with high-pressure steam. Care must be taken not to exceed safe working pressure of the system.

Where it is possible to break a number of joints in the piping, a swab made of rags secured firmly to a strong iron wire or cable can be pulled through each section of the system. If the rags are soaked in kerosene or other solvent, so much the better. After using the swab, the line should be thoroughly blown out with the steam.

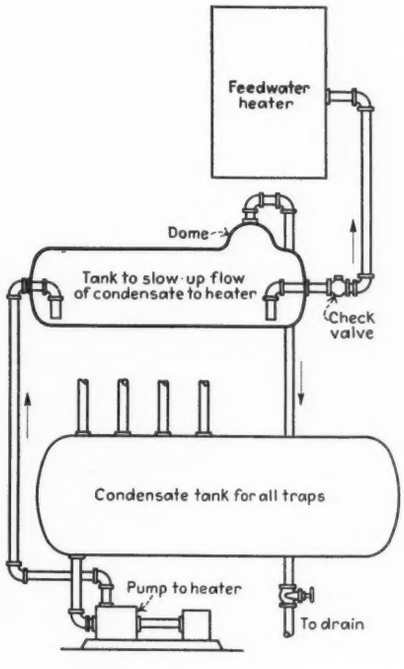
Another method is to circulate an alkaline cleaning solution through the system. A commercial cleaning compound such as "Oakite" may be used, or a mixture made up of equal parts of trisodium phosphate and soda ash is effective. Use 8 oz of this mixture and one oz of yellow soap powder to each gallon of water circulated. Steam should be admitted to keep the solution at a boiling point. After all oil has been removed, the system should be washed out with hot water and then blown out with steam.

If the piping system is so extensive or complicated that the above methods are impractical, condensate should be purified before being used as boiler feed in high-pressure boilers. Commercial filters will separate oil, previously coagulated with alum, from the water. The effluent of this type of filter is usually entirely suitable for high-pressure boiler feed.

Roanoke, Va. S H COLEMAN

Tank Removes Oil From Condensate

ALL OUR condensate flows to one tank in the basement. The feedwater heater is on the first floor. To remove the oil from the condensate, I placed a tank, 24 in. in diameter by 12 ft. long, with a dome, on the wall above the condensate tank, but below the heater, as in the figure. This tank was made with sufficient capacity to give constant pressure with no agitation of water when it is being pumped to the heater. Water passes through this tank so slowly that all the oil separates out and rises into the dome, from where it is drained two or three times each week. All the oil is taken out of the water because the boilers have remained clean since installing this system.



We have 22 steam cylinders in service, five of which are on engines and the remainder on pumps. The only oil separator on the system is one in a line leading to one building, all other condensate comes directly to condensate tank without separators.

Milwaukee, Wis. W H HIEL

Flaxseed Treatment

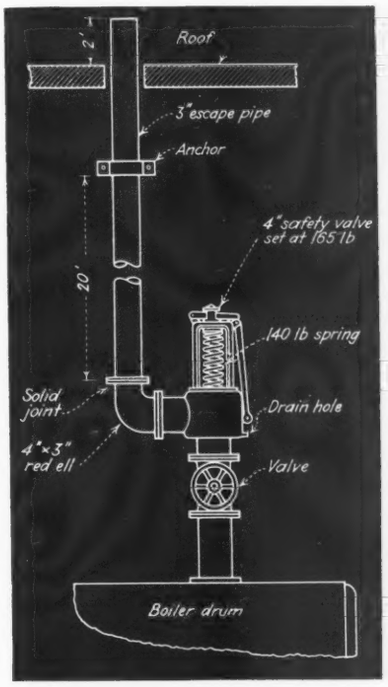
CYLINDER-OIL deposits in exhaust lines are usually rather difficult to remove. Oil that is specially refined to resist the washing action of steam in an engine cylinder will resist it in a pipeline.

Since H G has some time before the new plant is to be put into operation, a feedwater treatment using flaxseed emulsion can be used to advantage. We used this treatment on a ship on which I was employed, and every trace of oil was removed from lines, boilers and engines in about two weeks.

Flaxseed in a container is placed in a steam-tight tank. Steam at about 80

WHAT'S WRONG WITH THIS PICTURE?—XXI

Boiler Safety-Valve Piping



At least nine errors are shown in this drawing. Make a list of those you recognize, then compare with the list on page 708

lb pressure is piped in at the top and a drain and regulating valve placed at the bottom of the tank. Steam and hot water will boil an emulsion out of the flaxseed, which should be piped to the feed tank at the rate of approximately one drop each two or three seconds. The actual flaxseed should not be crushed, because a harmful oil is released from the hull. The feed tank or open heater must be carefully watched as oil will accumulate very rapidly as it is removed from the system. I have seen this method work with remarkable success; even oil in pores of cylinder and piston rods was removed.

If a more rapid elimination is desired, pipelines can be cleaned by circulating a solution made of 200 gal. of water plus 50 lb of sal-soda and 5 gal. of kerosene. Heat the solution to a boil, and maintain this temperature while circulating it through the system. Circulation should continue for about 12 hours, after which lines should be drained and washed out thoroughly with fresh water, changing water several times.

However, I think that the flaxseed treatment is the most efficient and can be used with the least trouble. The flaxseed can be bought from Filtrators Co, 96 Liberty St, New York, N.Y.

Houston, Tex. H G SCHEER

WHAT'S WRONG WITH THIS PICTURE?—XXI

***Boiler Safety-Valve Piping.* See page 707**

1. Valve between boiler drum and safety valve. Safety valves are placed on the boiler to prevent overpressure. Any obstruction in either inlet or escape connections may make safety valve inoperative and of no protective value.

2. No drain piping provided for the drain hole in the safety-valve casing. Piping is needed to protect boiler from corrosion due to leakage and to carry off safely any steam that might escape when the valve blows. Drain lines should contain no valves or pockets and should slope downward to point where disposal is made.

3. No drain for escape pipe. Provision should be made to drain the escape pipe at the lowest point.

4. Safety-valve discharge opening reduced. Reducing the discharge area prevents the valve from discharging its designed capacity.

5. Solid joint between safety valve and long, rigidly fastened escape pipe. Expansion and the forces set up by the escaping steam will throw undue strain on the valve. A packed expansion joint should be used or a suspended umbrella-type construction substituted.

6. Safety-valve spring designed for pressure below valve setting. Spring pressure should conform closely with operating pressure to prevent reduction in valve lift from excessive spring compression. The A S M E Boiler Code permits a 10% variation on either side of the spring design pressure.

7. Escape pipe too small. This pipe should be larger than the discharge opening of the valve to compensate for friction losses when the valve blows.

8. Escape pipe section above roof too short. Escape pipe should extend at least 6 ft above roof to avoid scalding any persons who might be in the vicinity when the valve blows.

9. No flashing provided for roof opening. Some form of protection should be provided to prevent leakage on boiler.

CURRENT COMMENT

Boiler Inspection In Texas

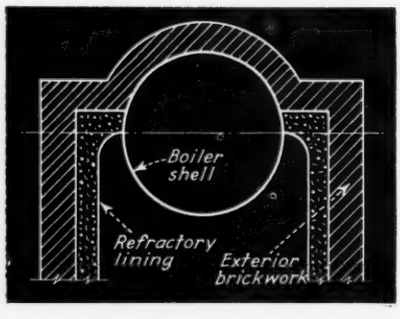
ON PAGE 532, September *Power*, there appeared an article on the new boiler inspection law in Texas. In the article, there was a statement to the effect that agents of insurance companies will be commissioned as inspectors of steam boilers upon passing an examination arranged by the State Bureau of Labor Statistics.

This statement is likely to be misleading, since the law in effect in Texas is similar to those in other code states, wherein only an inspector or engineer of an insurance company may be commissioned by the Bureau of Labor Statistics, after he has passed an examination, or holds a commission from the state with standard of examination equivalent to that in the State of Texas, or holds a commission from the National Board of Pressure Vessel Inspectors.

Hartford, Conn. J M GORHAM
Hartford Steam Boiler Inspection and Insurance Co

Refractory Lining for H R T Boiler Settings

IN THE DRAWING appearing at the bottom of page 520, September *Power*, the refractory lining cuts off practically 50% of the normal heating surface of the boiler. As we set boilers of this type, the refractory lining is corbelled over to meet the shell at the center line of the boiler, as in the diagram. This exposes the full half of the boiler shell to the fire.



Chicago, Ill. FRANK S REIDER
Plibrico Jointless Firebrick Co

Self-Controlled Gas Power

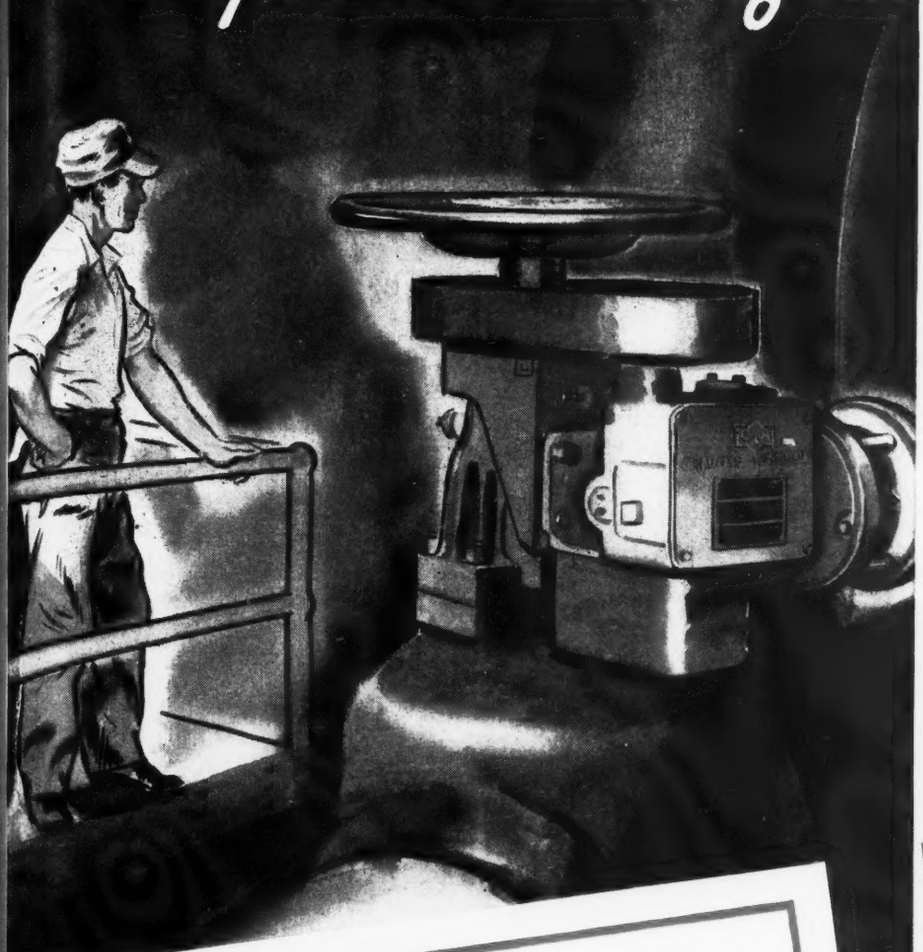
I HAVE heard a great many favorable comments on the article in September *Power*, "Self-Controlled Gas Power", apparently due to the opening for new gas-engine installations it points out. It is my opinion that the rate structure of the average power company will operate against the plan's success.

Most companies have standby rates, parallel-operation rates or other rates designed to cover the case where entire electric requirements are not regularly supplied by the utility. The method of operation outlined in Mr. Wenner's article not only makes the power-company's service standby but must be considered as parallel service, and one or another of the special rates will apply. The power companies justify this rate arrangement on the fact that such service would normally give little or no return on an investment that is as big as if full service were supplied. A charge of some kind must be made to cover fixed charges on this investment and operating costs such as transformer losses and commercial costs.

It is possible that for a time such installations could be made successfully in areas where the power company rate structure does not penalize low load factor or standby operation, but as soon as any number of gas engines are in operation, steps will be taken to correct the rate.

A little history will bear out this point. In 1924, Southern California faced a serious electric power shortage. This meant curtailing power requirements by approximately 25% or going to some other source of power. Gas engines, of course, represented an alternative and many installations were made, some of which were complete substitutions of gas-engine generation for central-station electric power, and others were installations identical to those described by Mr. Wenner. During the period of shortage this provided a welcome relief for the power company, but after the condition passed, the company realized the danger represented by this method of operation and took steps to correct the situation by filing rates for standby service and for parallel service, both applicable where the entire electric requirements were not regularly supplied by the power company.

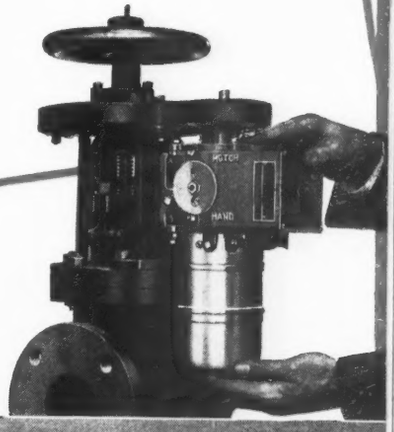
The Most Complete... The Most Thoroughly Engineered Line of Valve Control



Engineers aware of changed conditions today make full provision for Cutler-Hammer Valve Control in their construction and operating plans. C-H Valve Control brings them *new* speed, economy, convenience, precision control and safety to valve operation. And every engineer who has investigated, knows that C-H Valve Control undergoes breakdown tests of unprecedented severity, is designed to uncompromising standards, is superlatively engineered and constructed. For any valve from ¾ inch to 72, torque to 3,000 lbs. ft., in 84 different motor characteristics, C-H Valve Control offers so many distinctive features that you are invited to write for full details, stating your needs briefly. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1209 St. Paul Ave., Milwaukee, Wis.

LARGE For steam line temperatures so hot the valve glows . . . on pressures up to 3,000 lbs. . . . on liquid and gas valves . . . Cutler-Hammer B5 brings nearby or remote control at the touch of a button; sure starting, sure travel, sure seating; speed . . . and safety.

SMALL The C-H AA unit. Especially adapted to automatic and precision control of valves ¾" and up, in continuous-process plants, etc.



CUTLER-HAMMER
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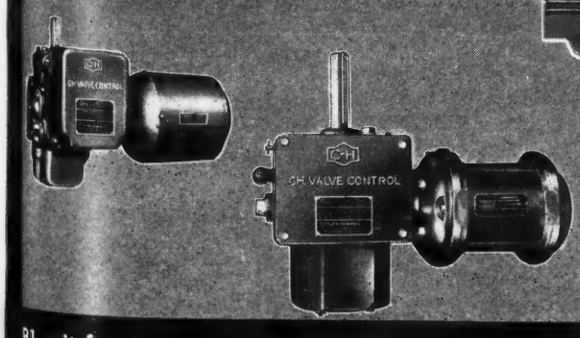
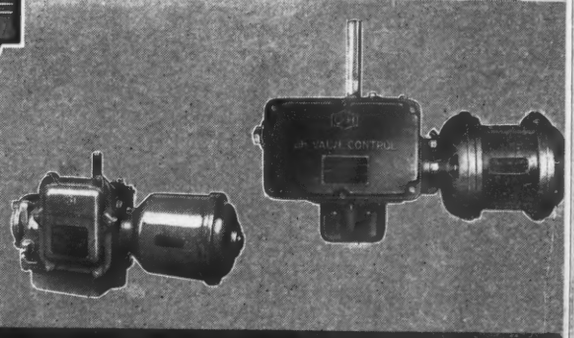
C-H

Furnished Completely Tested and Mounted by all Valve Manufacturers



B1 unit for torques from 30 to 125 lbs. ft.

B3 unit for torques from 250 to 500 lbs. ft.



Explosion-proof type

Submersible watertight type

In making these comments, it is not my intention to throw cold water on Mr. Wenner's scheme, but to caution your readers not to build too much hope on the results possible with this method of operation.

Los Angeles, Cal. C REMSCHED
Southern Counties Gas Co

Modern Plant Number Additions and Corrections

Several letters have been received listing additional plants and correcting data which appeared in the Mid-September number of *Power*. Additional plants include: 6000 kw for American Potash and Chemical Corp, Trona, Calif., United Engineers & Constructors, consultants; new boiler plant for New England Baptist Hospital, Roxbury, Mass., D D Eames, consultant; new boiler installation for Christian Science Benevolent Assn, Brookline, Mass., D D Eames, consultant.

United Engineers & Constructors, Inc., was consultant for Schuylkill Station of Philadelphia Electric Co and consultant and constructor for the new plant of Narragansett Electric Co and the Richmond Plant of Philadelphia Electric Co. William C Olsen was consultant for the municipal boiler installation at Rocky Mount, N. C., instead of Burns & McDonnell, as listed. The "Rhode Island Hospital" installation described on page 560 is probably better referred to as "Rhode Island Institutions," because there is a private hospital in Providence, R. I., which carries that specific name. The latter hospital added two 3500-sq ft, 200-lb crossdrum B & W boilers to its boiler plant last year. D D Eames was consultant. Olson Rug Co, Chicago, installed a power plant last year with a number of special features.

In the Industrial Power Plant tables, Carnegie-Illinois Steel Corp is listed twice. The first listing is correct, the second (in the range of 400-499 lb per sq in.) is incorrect and a duplication of the previous citation. In the table of equipment for the Cedar Rapids plant of Iowa Light & Power Co, the stokers are listed as supplied by "American Equipment Co," which should be "American Engineering Company."

Also, on the table of equipment for Springdale Station, West Penn Power Co, page 578, under coal-handling equipment, the ring-mill coal crusher was listed as manufactured by American Engineering Co. This is in error, the correct manufacturer being the American Pulverizer Co.

THE ENGINEER'S BOOKSHELF

Diesel Engines

DIESEL PLAN BOOK AND ENGINE CATALOG (VOL. II)—*John W Anderson, editor. Published by Rex Wadman, Diesel Engines Inc, 2 West 45th St, New York, N. Y. 320 pages. 10¼ x 13½ in. Spiral-ring binding. 610 illustrations. Price $3.*

Fifty-seven diesels are described in detail, illustrated in color in this second volume, with large, easily readable illustrations and much comparative data which aids in selection. There are also eighty-odd pages of diesel installation plans after the style of the volume published last year, and several chapters of engineering material on vibration and noise elimination, flexible connections and air filtration. The final 70 pages are engine and accessory advertising.

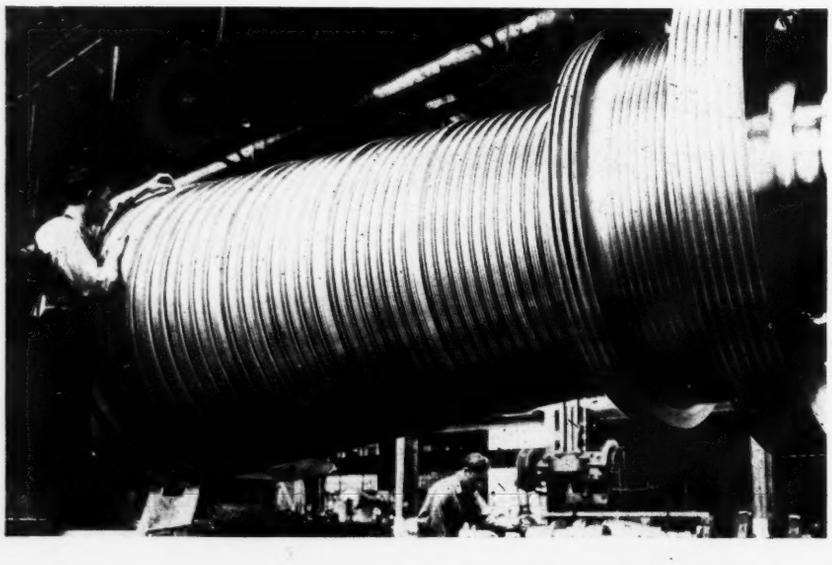
Axial-Flow Fans

THE THEORY AND PERFORMANCE OF AXIAL-FLOW FANS (*1937*)—*By Curt Keller. Adapted for the use of fan designers by Lionel S Marks and John R Weske. Published by McGraw-Hill Book Co, 330 West 42nd St, New York, N. Y. 140 pages, 6 x 9 in., 112 illustrations, 36 tables. Price $4.*

This book presents in English the results of original Swiss investigations of the application of airfoil theory to the design of axial-flow fans. Intended for the use of fan designers, the theory of the axial-flow fan is discussed principally by mathematical analysis.

QUINDARO TURBINE ROTOR.

Blading the huge turbine rotor for Quindaro Power Station, Kansas City, Kan., at Westinghouse's South Philadelphia plant. The turbine, to drive a 30,000-kw generator, will operate at a pressure of 400 lb per sq in. and a temperature of 725 F



Hydraulics

HYDRAULICS (*1937*)—*By R L Daugherty, professor of mechanical and hydraulic engineering, California Institute of Technology. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. Cloth cover, 460 pages, 6 x 9 in., 316 illustrations, 25 tables. Price $3.50.*

The first edition of this book was published 21 years ago. This, the fourth edition, is the result of a gradual development, and may be classed as a text on fluid mechanics applied to practical engineering problems. Principal attention has been given to broad fundamental principles and special cases have been introduced only where necessary and largely to illustrate applications of general principles.

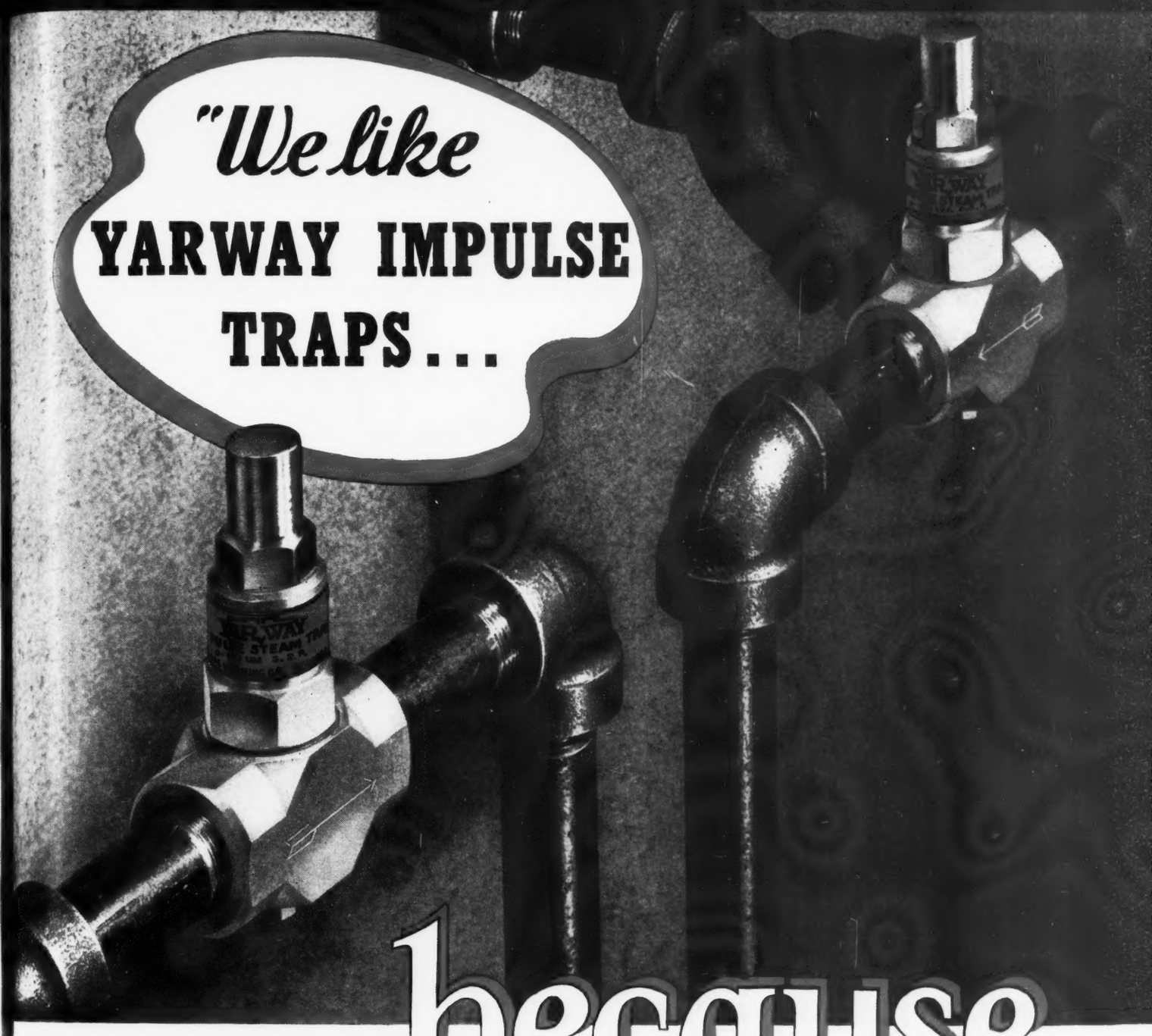
The text is divided into twenty chapters, seven of which are devoted to fundamental subjects such as properties of fluids, pressure, flow, and dynamic forces. Flow in pipes and open channels is covered in five chapters. Waterwheels, pumps and dams complete the list of subjects.

Treatment is essentially mathematical, but of the practical rather than abstract theory, so that the work is of value to the practicing hydraulic engineer as well as to students and research workers.

Testing I C Engines

TESTING INTERNAL COMBUSTION ENGINES (*1937*)—*By S J Young and R W J Pryer, Loughborough College (England). Published by D Van Nostrand Co, Inc, 250 Fourth Ave., New York, N. Y. 200 pages, 5½ x 8¾ in. 87 drawings, 21 tables, 2 appendices. Price $3.25.*

Planned for the technical college having an extensive course in internal-combustion engines, this text provides experiment and test data for a 3-year



"Its small size saves space. We also like its flexibility on different pressures." —*Chief Engineer, Motorcar Mfg.*

"Its continuous draining feature permits closer temperature regulation." —*Chrome-plating Plant.*

"More economical to replace with Yarways than to repair old type traps." —*An Eastern Railroad.*

"They give so little trouble we hardly know they are in the plant." —*a Philadelphia Jute Mill.*

"Their high capacity on cold water speeds our press operation." —*a Plastic Molding Co.*

"There are no castings to crack—no gaskets to blow out on high pressures and temperatures." —*Ohio Paper Co.*

"It won't freeze when used outside—and discharges against back pressure." —*Automobile Plant.*

"Dryers heat faster—and stay hot." —*a Brooklyn Laundry.*

"They save us 12 hours of heating time before unloading tankers." —*Oil Transportation Co., using 1,080 Yarway Traps.*

"They required less pipe and fittings to install . . . they give us faster heating and a 10° to 23° F. increase in temperature . . . and have saved us a substantial amount of coal." —*Large New Jersey Hospital.*

Thus—everywhere, users tell the story of Yarway Impulse Steam Trap satisfaction. They tried them. They convinced themselves. They standardized on Yarways. Why don't you? Your nearby supply house has them. Or write for Bulletin T-1722.

YARNALL-WARING COMPANY
100 Mermaid Ave. · Philadelphia

YARWAY IMPULSE STEAM TRAP

The Trap Everyone is Talking About

course. Chapter titles indicate the nature of the experiments: Engine Timing, Brake-Horsepower Tests, Fuel-Consumption Tests, Indicator Tests, Special Uses of the Indicator Diagrams, Heat Losses, Measurement of Air Consumption and Volumetric Efficiency, Miscellaneous Experiments. Appendices cover dynamometer sizes and effect of dynamometer position on torque readings.

The book is arranged not as a series of experiments, but rather as a continuing discussion from which desired tests or experiments can be selected. In this way the coordination between various tests is pointed out and the student obtains a series of related results rather than a set of individualized tests not obviously interrelated. Equipment in most cases is simple and can be built in the usual college laboratory.

The professional engine tester will find here many pointers that will make him, as H R Ricardo says, "more than a match for the engine."

Engineering Mechanics

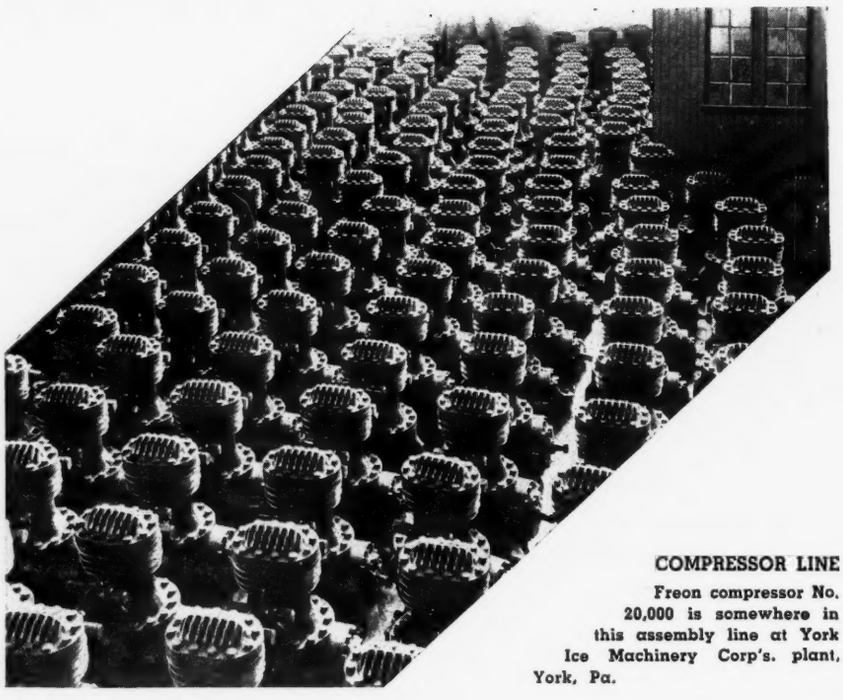
ENGINEERING MECHANICS *(1937)—By S Timoshanko and D H Young. Published in two volumes by McGraw-Hill Book Co, 330 West 42nd St, New York, N. Y. Statics, 329 pages, 6 x 9 in., 46 illustrations, 336 problems. Dynamics, 318 pages, 6 x 9 in., 314 illustrations, 353 problems. Price each volume, $2.75.*

Intended as standard text for university training, both volumes are arranged to give the student as many general methods of attack as possible and to illustrate the methods with practical engineering problems. Statics requires a knowledge of mathematics up to and including differential calculus; the treatment of Dynamics involves simple differential equations.

BRIEF REVIEWS

PENETRATION OF OIL SPRAYS. *By P H Schweitzer. Bulletin 46 of Engineering Experiment Station, Pennsylvania State College, State College, Pa. 78 pages, 5½ illustrations, Price 75 cents*—Latest as well as earlier results of investigations carried on at Pennsylvania State College on penetration of oil sprays with primary regard to Diesels. Four chapters: Motion of Spray Tip, Real Motion of Sprayed Oil, Building Up Period of Spray, and Accessory Experiments. Summaries after first three chapters facilitate calculations of the penetration for various conditions.

MAP OF ELECTRIC TRANSMISSION AND DISTRIBUTION LINES IN ILLINOIS. *Printed by State Rural Electrification Committee, Springfield, Ill. Price $1*—A very complete map which shows all transmission lines; all generating stations, whether municipal, public utility, industrial or cooperative; and also indicates whether a generating station is used for base load or standby, whether steam, hydro, or internal combustion, and shows kilowatt capacity. 30x50 in.



COMPRESSOR LINE

Freon compressor No. 20,000 is somewhere in this assembly line at York Ice Machinery Corp's. plant, York, Pa.

25 Years Ago IN POWER

A SHORT cryptic note in a "Personals" column said: "Thomas A Edison has been elected president of the Edison Manufacturing Companies, succeeding Frank L Dyer, resigned."

ON NOVEMBER 21-23, 1912, the Ohio Society of Mechanical, Electrical and Steam Engineers met in Akron, Ohio. A feature of the program was "an automobile ride around the lakes." This was put over to the last day of the meeting, so that if the automobiles broke down, the boys wouldn't spend all their time getting back from the trip.

TWENTY-FIVE years ago the patent-medicine man was in his heyday. And "quack" prescriptions weren't just limited to keeping men healthy, they extended into all fields. *Power* slew itself a dragon in its Nov. 5, 1912, issue (*Power* was then a weekly) when it exposed a compound that was "guaranteed" to work marvelous savings on the coal bill.

You were supposed to buy a ton of this compound (price $90), mix in the ratio of a pound to a gallon of water, and sprinkle eight gallons of this mixture on each ton of coal. Net result was alleged to be that a given quantity of coal would evaporate 25 to 26% more water than could be evaporated under the same conditions of temperature and pressure with untreated coal.

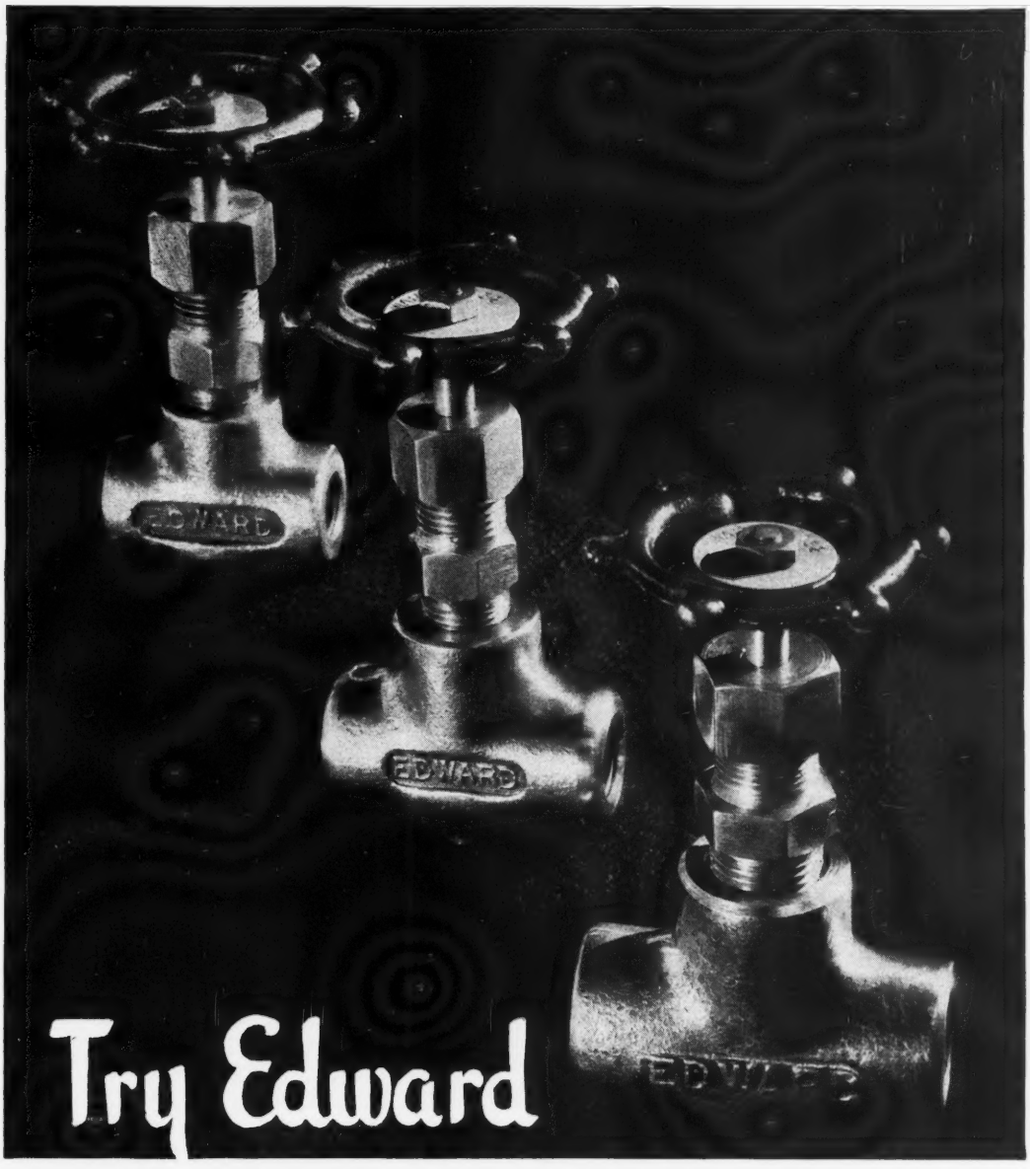
Power published a letter from a prominent firm of consulting chemists, which stated that the compound was practically all common salt mixed with some potassium permanganate and some zinc salt. Nothing more was heard from the compound manufacturer.

EVEN as today, there were poets 25 years ago. A contributor sent in this gem:

TEN LITTLE ENGINEERS

Ten little engineers running a turbine,
One lost his vacuum; then there were nine.
Nine little engineers figuring water rate,
One fell in the test tank; then there were eight.
Eight little engineers worked till half past 'leven,
One dropped in the flywheel; then there were seven.
Seven little engineers in an awful fix!
One blocked the safety valve; then there were six.
Six little engineers in a grimy hive,
One asked for sixty bucks; then there were but five.
Five little engineers strutting 'round the floor,
One broke the governor; then there were but four.
Four little engineers taking down a tee,
Took off all the nuts at once; then there were but three.
Three little engineers cleaning out a flue,
Along came a back draft; then there were but two.
Two little engineers having lots of fun,
One leaned on a live switch; then there was but one.
One little engineer stayed there all alone,
Till the owner bought his power—now there are none!

SMOKE abatement evidently wasn't very far along in 1912. A newly appointed smoke inspector in a midwestern city (*Power* claimed that he must have been a politician's cousin) filed this report: "I certify that I have inspected the smoke of this city for the thirty days past. I find plenty of smoke and apparently of good quality. Respectfully submitted."

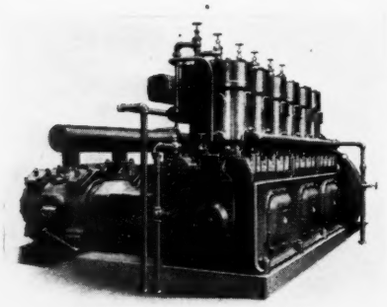


FORGED BODY Gage Valves

HAVE you ever used these sturdy low-priced needle valves? Every plant has places for them. Good for pressures up to 4000 pounds, these drop forged body valves save money in ordinary service. Each part, true to Edward quality tradition, is just right for its job. The latest improved series, shown in the photograph in sizes ¼", ⅜" and ½", has everything . . . titegrip malleable handwheel . . . safety taper-threaded bonnet joint . . . wearing parts hardened for long life . . .tailor-made packing in deep stuffing box . . . packable under pressure . . . carbon and alloy steels for special services. Stocked for immediate delivery.

The Edward Valve & Manufacturing Co., Inc.
EAST CHICAGO « « » » INDIANA

WHAT'S NEW IN PLANT EQUIPMENT



GAS-ENGINE COMPRESSOR

TYPE LCE 4-cycle, angle-type gas-engine compressor designed as medium-sized, self-powered unit for processing needs of refineries and natural-gasoline plants, gas-transportation lines, gas- or air-lift pumping, refrigeration, etc. One to four compressor cylinders (75 to 300 hp); all compressor cylinders are horizontal and at right angles to power cylinders. Each compressor cylinder has two corresponding power cylinders, and compressor element can be arranged to deliver any combination of volume and pressure within limits of engine rating. Force-feed lubrication with deep oil sump at engine base; separate lubricator for cylinders.

Worthington Pump & Machinery Corp, Harrison, N. J.

DIESEL-DRIVEN AIR COMPRESSORS

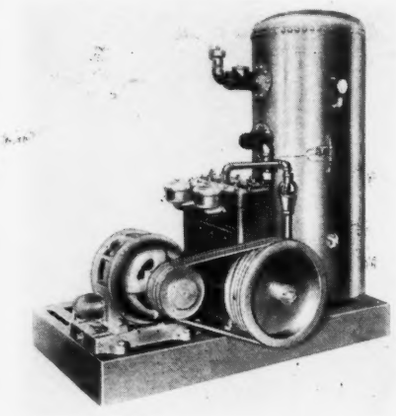
TWO MODELS, stationary and portable (stationary in illustration). Model WO-2 portable unit consists of CP Type 48 vertical, 4-cyl, 4-cycle, medium-speed diesel on common crankcase and crankshaft with V-type 2-stage, double-acting, water-cooled compressor, with cooling system and air receiver, all on structural-steel deck, arranged for mounting on skids or wheels. Capacity of 700 cu ft per min. Stationary model W-CO uses same engine and compressor as WO-2, but is arranged for mounting on permanent foundation or skids. Sizes of 3 or 4 engine cylinders, rated 112½ and 150 hp respectively, with 2-stage compressor cylinders, having piston displacements of 655 and 830 cu ft per min, respectively.

Chicago Pneumatic Tool Co, 6 E 44th St, New York, N. Y.

AIR COMPRESSOR

"UTILITY" stationary compressor for belt drive made in seven sizes ranging from 120 to 600 cu ft. Unit includes compressor, 1800-rpm motor, short V-belt drive and vertical air receiver mounted on single-frame base. Force-feed lubrication, mechanically-operated intake valve, discharge valve occupying full head area, and water cooling. All sizes adaptable to installations with or without motor or air receiver, and with belt drive or built-in direct motor drive.

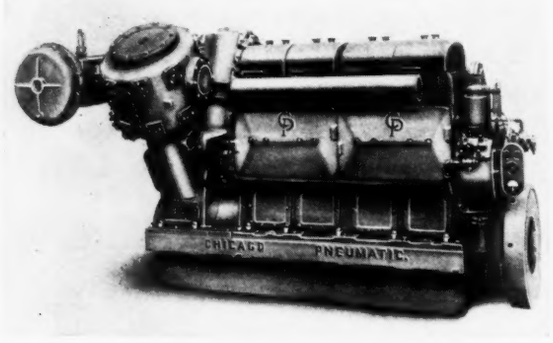
Schramm Inc, West Chester, Pa.

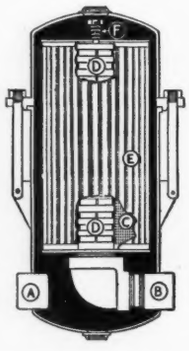


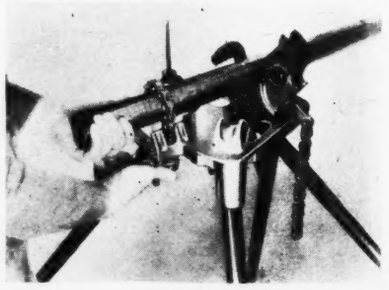
LUBRICATING-OIL FILTER

MODEL OPHL "liquid line" filter made mainly for horizontal oil lines. Plug in bottom of filter shell can be removed for draining. May be opened quickly for inspection and cleaning, either by loosening fasteners of swing-bolt models or by unscrewing locking lugs on bolted models. Cutaway outline drawing illustrates construction of high-pressure unit: inlet and outlet respectively *A* and *B*, wire-mesh frame of radial fin *C*, reinforced core *D*, filter insert *E*, and retaining spring *F*. Low-pressure model does not have reinforced core or retaining spring. Sizes and models for all capacities; model illustrated for 125-lb pressure.

Stayncw Filter Corp, Rochester, N. Y.



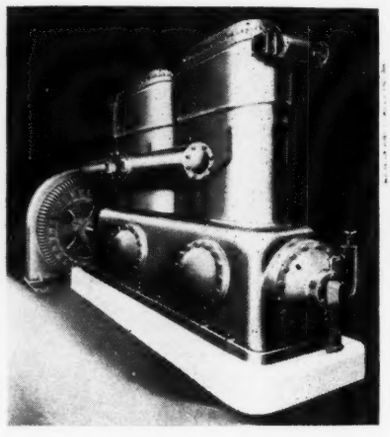




PIPE TOOL

PORTABLE "Vulcan" vise stand No. V-1 combines vise stand, chain pipe vise, and a pipe bender. Legs of 1-in. pipe with upset feet fold for carrying, and are held together by a tie chain. Vise jaw is of tool steel and base of malleable iron. Stand weighs 35 lb and takes pipe from ⅛ to 2 in. in diameter. Pipe bender handles pipe up to ¾ in.

J. H Williams & Co, 75 Spring St, New York, N. Y.



AMMONIA COMPRESSOR

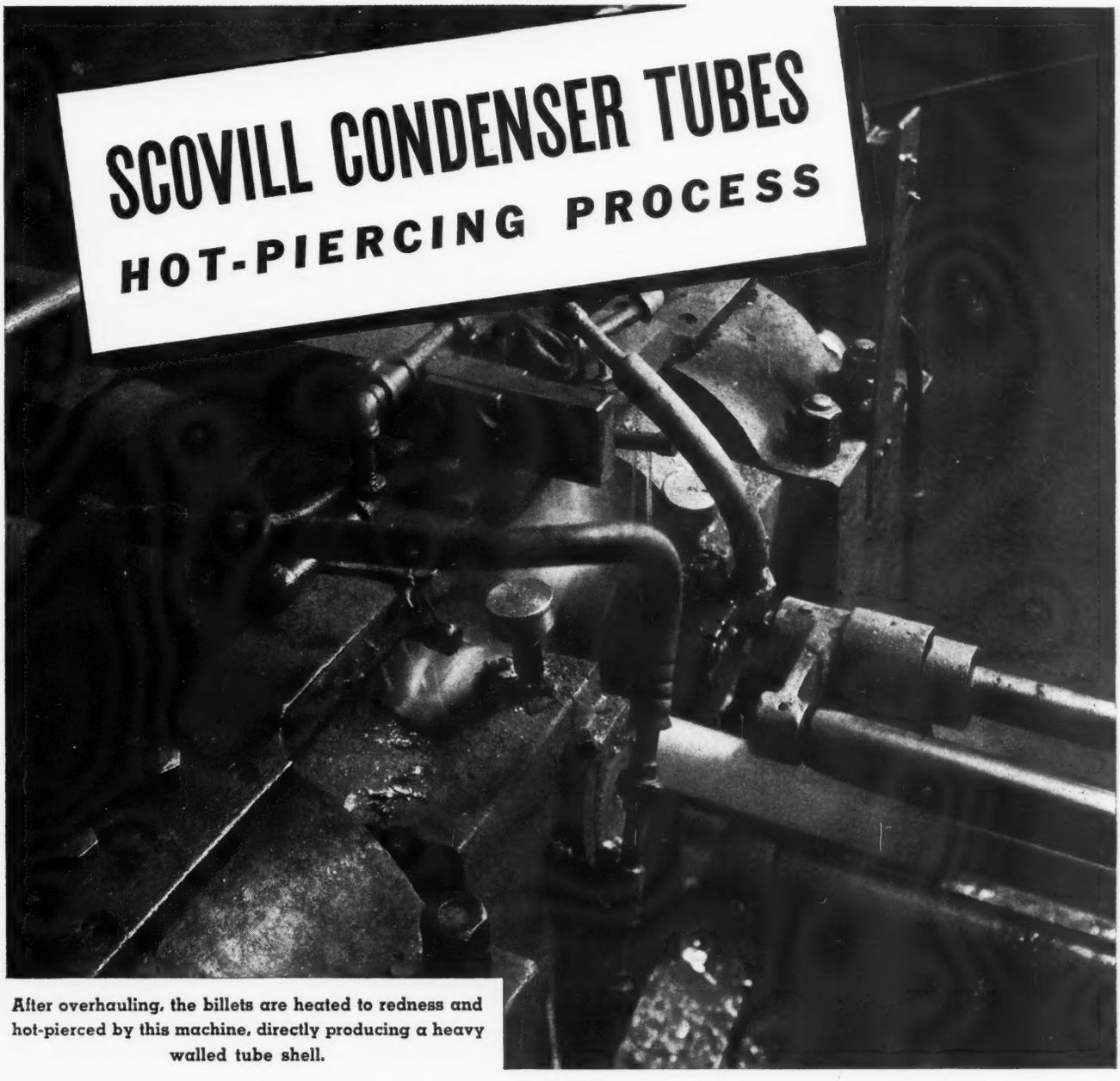
HIGH-SPEED, multiple-cylinder ammonia compressor follows general construction of York vertical single-acting compressors. Light-weight valves, pressure lubrication throughout and high rotative speeds. Built in sizes to furnish from 100 to 800 tons of refrigeration. Although designed for synchronous-motor drive, machine may be adapted for any type of prime mover. Meets requirements of small floor space and low headroom.

York Ice Machinery Corp, York, Pa.

MOTOR FOR DEEP-WELL PUMPING

VERTICAL, hollow-shaft, squirrel-cage, low-starting-current induction motor has simplified oiling system, ball-type guide bearing, high full-load speed, adequate starting torque, double-end ventilation, and full mechanical protection. Oil housing is on top end shield and divided in two parts by cylindrical wall which

SCOVILL CONDENSER TUBES
HOT-PIERCING PROCESS



After overhauling, the billets are heated to redness and hot-pierced by this machine, directly producing a heavy walled tube shell.

● In production by this method, the metal is melted in electric furnaces under pyrometric control. When the correct pouring temperature is reached, the metal is cast into long, solid cylindrical billets. After inspection, trimming and cutting to length, the billets are machined to remove the outside surface, then heated to redness and hot-pierced into heavy gauge shells.

These shells are next cut to length and put through a machine which reduces the wall thickness and diameter of the tube and increases the length.

When mechanically finished, the tubes are cut to length, burred, gauged for inside and outside diameter and wall thickness, visually inspected internally and externally, and then tested under both water and air pressure. Samples are subjected to flattening, flaring and beading tests. These extra precautions to insure top quality are taken with all Scovill condenser tubes. A booklet, "Scovill Condenser Tubes," gives the story in greater detail. It will be sent on request to engineers and purchasing agents.

SCOVILL MANUFACTURING COMPANY

13 MILL STREET, WATERBURY, CONNECTICUT

SCOVILL CONDENSER TUBES PROVE DEPENDABLE SCOVILL

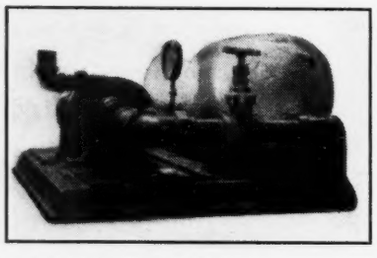
supports outer race of thrust bearing. Oil gage is arranged so that when full, oil level is even with top of balls in thrust bearing. With double-end ventilation, cooling air is drawn in under top cover and through side openings in motor base. Air cools coil ends and punchings, and then blows out through discharge openings in stator frame.

General Electric Co, Schenectady, N.Y.

BOILER-RETURN SYSTEM

"No-Vent" return system is designed to return condensate directly to boiler at practically same temperature and pressure as steam entering steam-heated cookers and driers initially. Centrifugal pump operates continuously whether condensate or steam happens to be in casing, without damaging pump. Cast-iron receivers are tested to twice working pressure. Manufacturer states that system eliminates vent (high-pressure flash steam) and divorces high-pressure steam circuit from all low-pressure exhaust steam, thereby lowering exhaust pressure in engines and giving more flexible heat balance.

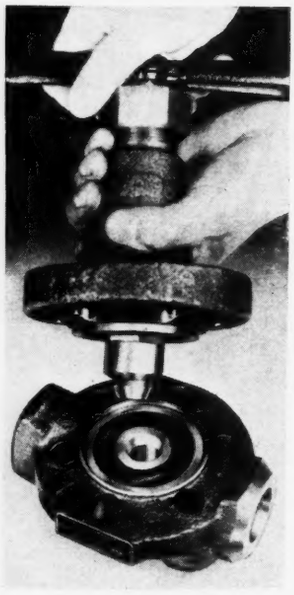
David Stout & Sons, Inc, 406 Market St, St. Louis, Mo.



SELF-CONTAINED BOILER

Small, self-contained boiler for automatic operation made in three sizes for evaporation of 500, 800 and 1200 lb of water per hr. Pressure range from 50 to 1000 lb per sq in., with total temperatures up to 850 F. Oil fired under automatic regulation with electric ignition. Natural-circulation water-tube boiler has two drums, and furnace is formed by extension of two rows of tubes. Integral economizer can be supplied if desired. Tests at operating pressures from 275 to 500 lb, ranged from 81.2 to 83% based on heat content of 19,300 Btu per lb of oil.

Steam Motors, Inc, Newton, Mass.



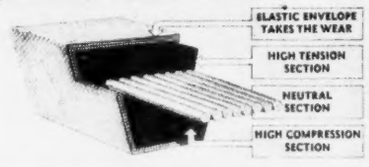
HIGH-PRESSURE HIGH-TEMPERATURE VALVE

"Duravalve," for high-temperature and high-pressure service, has internal Stellite seats. Design permits Stellite seat facing to be easily welded in and serviced even on small size valves. Made in one basic size, and then tapped or bored, for welding, for $\frac{1}{2}$-, $\frac{3}{4}$-, or 1-in. pipe. Manufacturer states that this simplification will take care of 90% of small-valve requirements on any high-pressure power-plant job.

Hancock Valve Div, Manning, Maxwell & Moore, Inc, Bridgeport, Conn.

MULTI-V BELT

Close matching of multiple belts equalizes strain and load carrying. Load is carried by a layer of heavy, low-stretch, high-tensile cord, placed on a neutral sec-



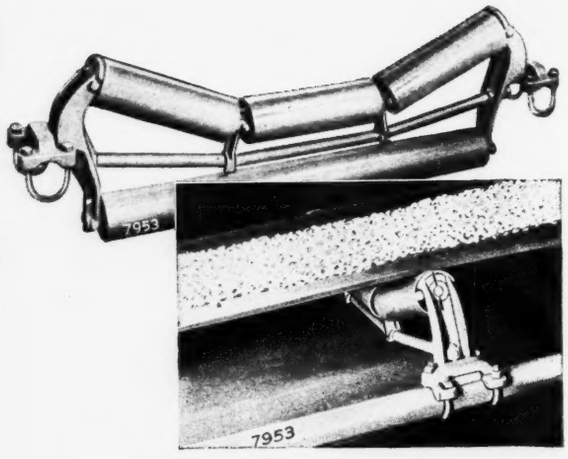
tion between rubber high-tension and high-compression sections. Surface wear is taken by elastic-fabric envelope with weave on the bias.

Goodyear Tire & Rubber Co, Inc, Akron, Ohio.

COAL VALVE

Bodies of "Seco" coal valves fabricated from $\frac{3}{8}$-in. steel plate by electric welding and grinding. Gate is driven by protected double-rack and pinions to eliminate binding. Gate and pinion shaft are mounted on ball-bearings with grease fittings and metal dust seals. Made with pocket sheaves and chain, or hand wheels. 12-, 14-, 16- and 18-in. sizes with either square or round top and bottom flanges.

Stock Engineering Co, Penton Bldg. Cleveland, Ohio.



BELT-CONVEYOR CARRIER

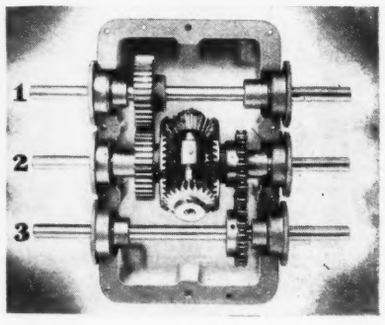
Light-weight, rigid-truss frame is supported on two parallel pipes. Carrier brackets are clamped to pipes without boring holes. By using standard piping, light sturdy conveyor frame can be quickly assembled from standard materials. Rocker mounting permits carrier to tilt in either direction with travel of belt. In this way, even reversible-direction belt is centered on carriers without guide rollers. Permanently sealed ball bearings increase life and reduce maintenance cost. Made either with or without return rollers as integral part of carrier.

Stephens-Adamson Mfg Co, Aurora, Ill.

DIFFERENTIAL CONTROL FOR VARIABLE-SPEED TRANSMISSION

Model MDB-3, for synchronization of two or more machines or parts of single machine, etc, has within unit housing three parallel shafts operating in a bath of oil. Gears of 1:1 ratio drive between shaft 1 and differential gearing. Between shaft 3 and differential gearing is 1:1 chain drive. For automatic control service, shafts 1 and 3 are connected to driven machine or machines. Shaft 2 is connected to speed-changing screw of Reeves transmission. When shafts 1 and 3 are driven in same direction at same speed, shaft 2 stands still. When speed of driven machine varies above or below desired speed, variation is transmitted to shaft 2 which speeds up or slows down transmission until synchronous speed is restored. Infinite range of speed variation is possible by connecting shafts 1 and 3 to constant and variable speed shafts of transmission.

Reeves Pulley Co, Columbus, Ind.



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CORPORATION

PIONEERS IN AUTOMATIC COMBUSTION CONTROL
FOR NEARLY A QUARTER OF A CENTURY

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LABORATORIES, INC.

CONSULTANTS ON BOILER WATER PROBLEMS

BUROMIN
COMPANY

EXCLUSIVE SALES REPRESENTATIVES
"HALL SYSTEM" AND "HAGAN PHOSPHATE"
FOR BOILER WATER CONDITIONING

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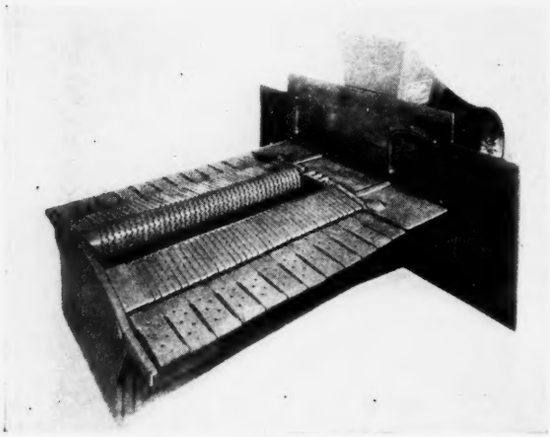
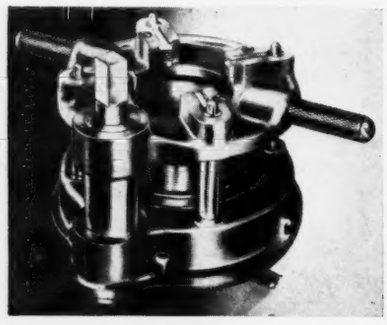
write HAGAN CORPORATION, 304 Ross Street, Pittsburgh, Pa.



UNDERFEED STOKER

LOW HEADROOM ram, underfeed stoker is of all-metal construction, including windbox with sliding cleanout panels. Dustproof gearbox has Timken bearings; motor mounted 24 in. off floor level and connected with protective shield. Retort ram is adjustable while stoker is in operation; seven feed adjustments and unlimited air adjustments.

Canton Stoker Corp, Andrew Place, S W, Canton, Ohio.



PIPE THREADER

MODEL 48-R threads 2½-, 3-, 3½-, and 4-in. pipe. Extra wide die has wide throat to center and hold tool on pipe. Fully-enclosed gears keep out chips and dirt. Driving pinion is straddle-mounted, with bearings both above and below gear teeth on pinion. Proper position for setting dies to cut standard thread is marked by shoulder on tapered post. Net weight, 58 lb; cuts right-hand American thread.

Beaver Pipe Tools, Inc, Warren, Ohio.

CONSTANT-LEVEL OILER

"LEVOMATIC" automatically maintains oil level in ring and ball bearings of motors, line shafts, pumps, and other machinery having oil wells. As oil is consumed in bearing chamber, it is automatically replaced with fresh oil from reservoir. Clear glass reservoir is screwed to solid bronze cadmium-plated fitting.

Trico Fuse Mfg Co, Milwaukee, Wis.

DISTANT-READING WATER GAGE

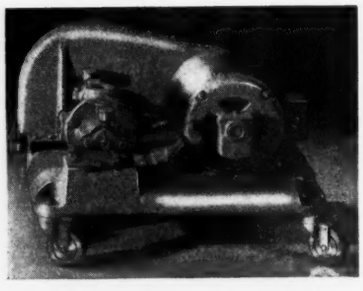
"EYE-HYE" gage may be located on instrument board or other convenient place, and connected to actual water gage on water column or boiler drum by means of copper tubing which may be bent around obstructions as desired. Water level is shown on "Eye-Hye" gage by bright green liquid. Made for pressures up to 250 lb.

Reliance Gauge Column Co, Cleveland, Ohio.

PORTABLE ROTARY PUMP

V-BELT drive from motor to pump is completely enclosed by removable guard. Silent-chain drive can be furnished in place of V-belt if desired. Unit has casters for portability, but can be ordered without casters for permanent installation. Pump can be driven from lighting circuit, tapping in at nearest electric outlet. Two sizes, 10 and 20 gpm. Positive in displacement; designed for high-suction lifts; needs no priming.

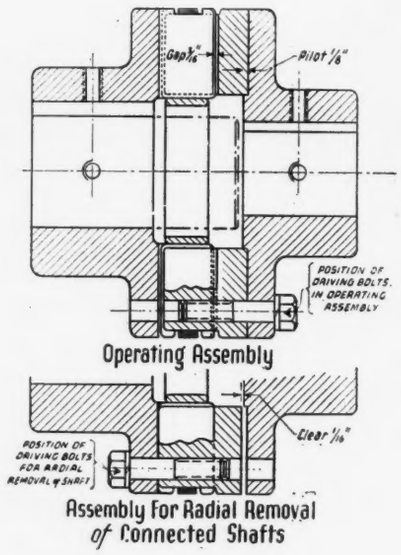
Blackmer Pump Co, Grand Rapids, Mich.



FLEXIBLE COUPLING

TYPE W flexible coupling has one set of jaws made in form of a removable ring, which is held in place and driven by 3-, 5-, 7-, or 9-hexagon head alloy-steel capscrews operating from jaw body. As pilot which holds jaw ring in place is ⅛ in. deep, and gap between cushions and jaw body is 7/16 in., when removable jaw ring is pulled over, there develops a clearance of 1/16 in., ample for rotating either half of coupling. Cushions are free floating between metal jaws and retained in place by steel band. Bores of 1½ to 14 in. (2 to 2,000 hp at 100 rpm).

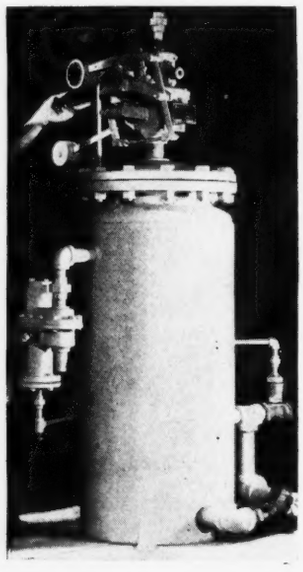
Lovejoy Flexible Coupling Co, 4976 W Lake St, Chicago, Ill.


Gap 7/16"
Pilot 1/8"
POSITION OF DRIVING BOLTS IN OPERATING ASSEMBLY
Operating Assembly
POSITION OF DRIVING BOLTS FOR RADIAL REMOVAL OF SHAFT
Clear 1/16"
Assembly for Radial Removal of Connected Shafts

LIQUID-HANDLING UNIT

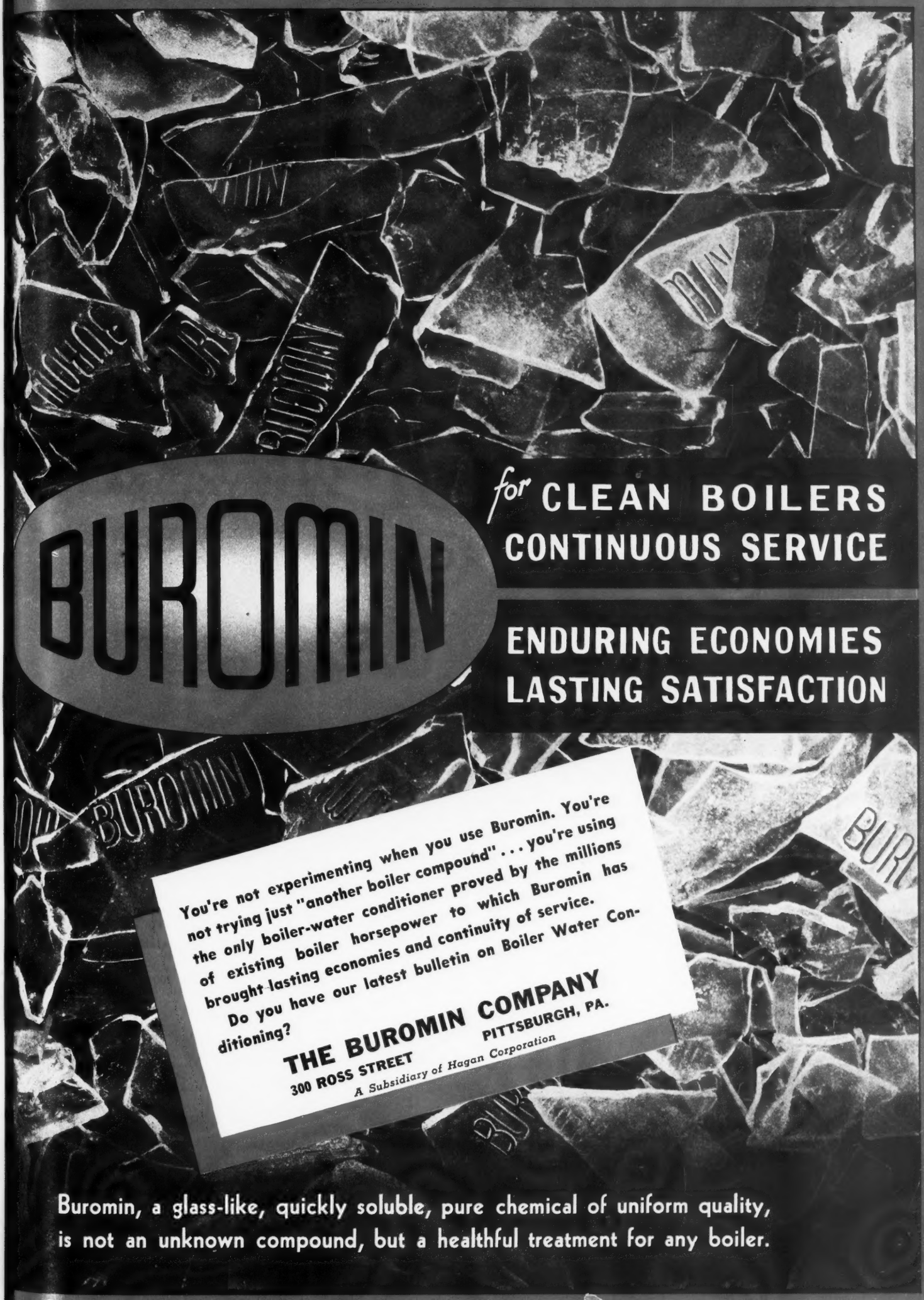
DIRECT-PRESSURE "Liquivator" consists of stationary pressure tank to which an operating valve mechanism is externally connected. Counter-weighted displacement tanks within pressure tank provide power for valve control through leverage. Since valve mechanism is separate from tank, it may be assembled with any size tank for handling any given volume of liquid. Made in both metering and non-metering types. Either type can be furnished in a self-contained or remote-control assembly to meet individual requirements.

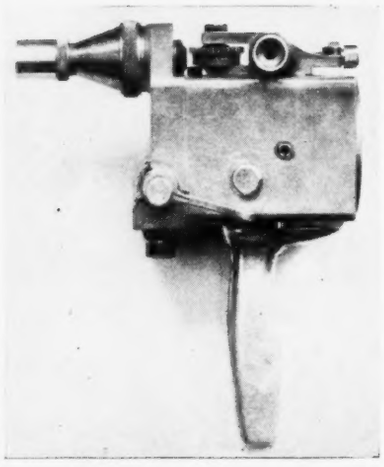
Morehead Mfg Co, Detroit, Mich.



METAL-SPRAY GUN

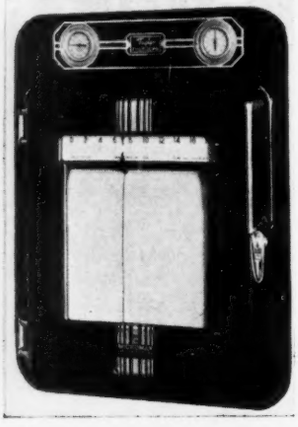
IMPROVED "Majestic MetalayeR" said to deposit approximately 100% more metal over a given time with about ⅓ less oxygen and acetylene consumption per


BUROMIN
for CLEAN BOILERS
CONTINUOUS SERVICE
ENDURING ECONOMIES
LASTING SATISFACTION
You're not experimenting when you use Buromin. You're not trying just "another boiler compound" . . . you're using the only boiler-water conditioner proved by the millions of existing boiler horsepower to which Buromin has brought lasting economies and continuity of service.
Do you have our latest bulletin on Boiler Water Conditioning?
THE BUROMIN COMPANY
300 ROSS STREET PITTSBURGH, PA.
A Subsidiary of Hagan Corporation
Buromin, a glass-like, quickly soluble, pure chemical of uniform quality, is not an unknown compound, but a healthful treatment for any boiler.



weight of metal deposited on larger-size wires. Train of gearing from turbine to final feed roll consists of two hardened worms, one bronze and one fibre gear of special composition, enclosed in single compartment. Illustration of gun without protective cover to show feed rolls.

Metals Coating Co of America, 495 N Third St, Philadelphia, Pa.



POTENTIOMETER CONTROLLER

"Fulscope Micromax" air-operated potentiometer controller has same adjustable, air-operated control mechanism used in "Fulscope" temperature, pressure, rate-of-flow, and liquid-level controllers. Temperature-measuring system (Micromax) gives automatic reference-junction compensation, positive balancing of potentiometer circuit, and current standardization. Fulscope control unit operates in conjunction with Taylor "Motosteel" diaphragm valve. Where precision valve action, or both precision valve action and compensation for load changes, may be necessary to prevent deviation from control point, Fulscope can be supplemented with "Valve-Precisor" or "Dubl-Response" control unit, respectively.

Taylor Instrument Cos, Rochester, N.Y.

PYROMETER CONTROLLER

"Alnor" pyrometer controller, for automatically controlling temperatures, operates on electronic principle similar to a radio circuit. When temperature pointer with its vane approaches temperature setting, vanes of pointer and target interleave and produce a circuit change which in turn operates a relay. Heating current if electric is shut off, or in case of fuel firing, fuel valve is closed partially or completely depending on type of valve used. Red bull's eye indicates whether heat in furnace is on or off.

Illinois Testing Laboratories, Inc, 420 N La Salle St, Chicago, Ill.

UNIT HEATER *(photo right)*

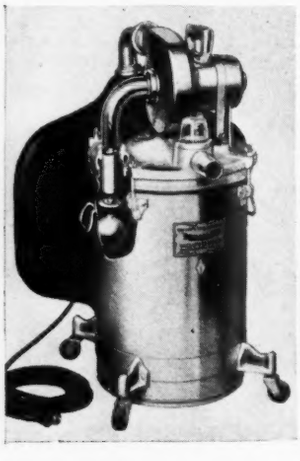
"Thermolier De Luxe" unit is an industrial heater in a modern housing finished in crackle black and satin chrome. Heat distribution has been improved by new angular louvres which provide widespread heat flow. Inlet and outlet pipes have been relocated at rear, and specially-designed motor and fan are concealed.

Grinnell Co, Inc, Providence, R.I.

INDUSTRIAL CLEANING EQUIPMENT

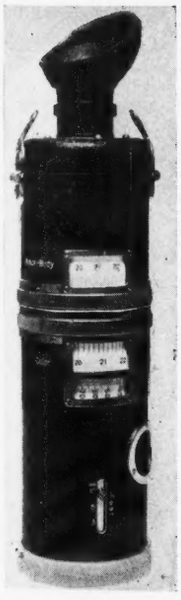
Improved industrial vacuum cleaner and portable electric blower removes dust and dirt from motors, machinery, etc. "Tornado" portable cleaner, Model 112, has double-size dust bag. "Tornado" blower, Models 6A and 8A, now built with enclosed ball bearing assembly and screen over end of motor housing to keep out dust and dirt.

Breuer Electric Mfg Co, Chicago, Ill.

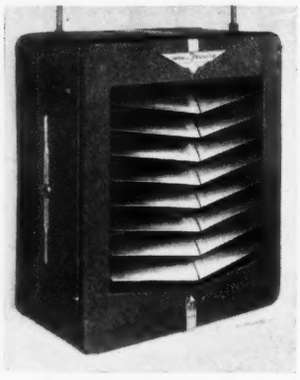


PYROMETER

"Bi-Optical" pyrometer based on use of light filters and color wedges, which are transparent to a number of colors simultaneously. By using filters with a number of transparencies both for separation and toning down, complicated optical or mechanical devices are obviated, and a simple temperature-measuring device in the form of colored discs is made possible. Scale ranges of 900 to 1900 C or 1700-3500 F. Said to be only instrument by which temperature of "black body" and "actual" temperature can be determined simultaneously.



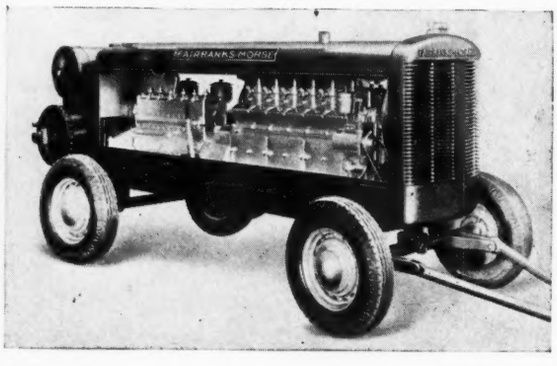
Pyrometer Instrument Co, 103-105 Lafayette St, New York, N.Y.



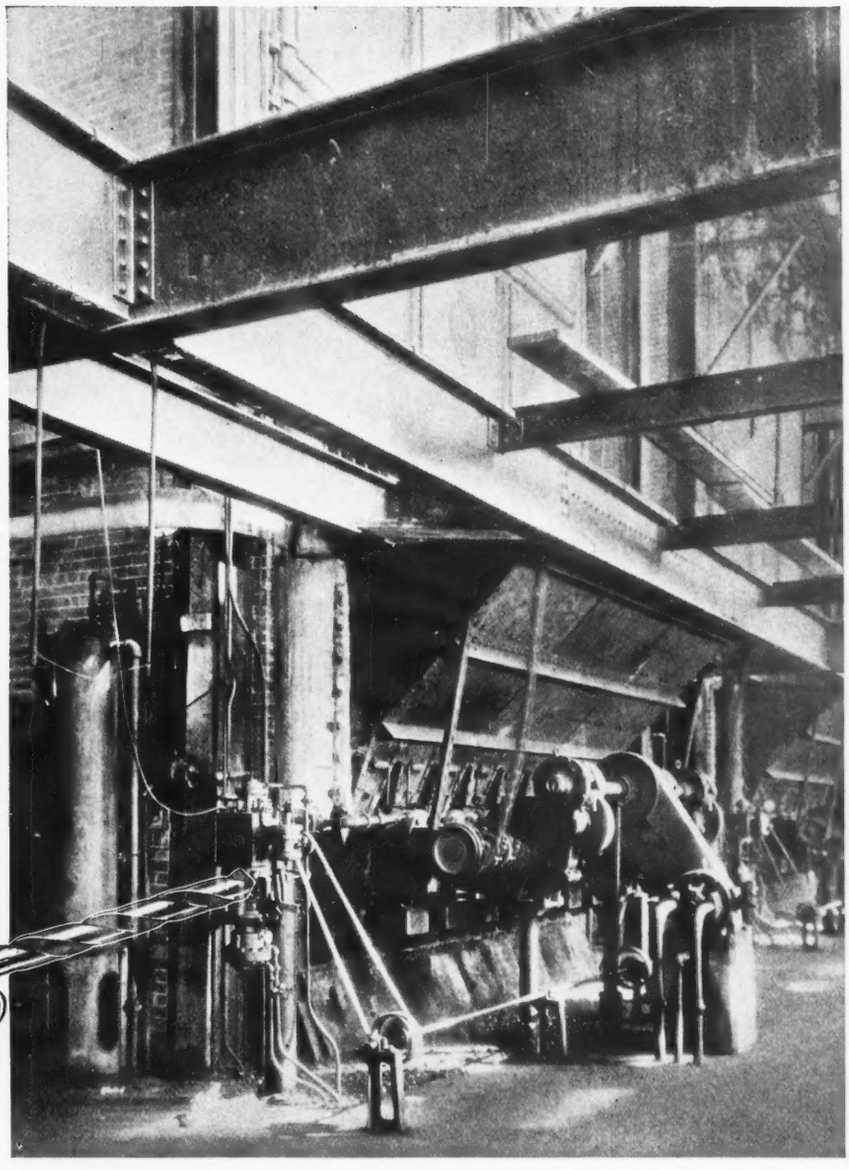
DIESEL-POWERED AIR COMPRESSOR

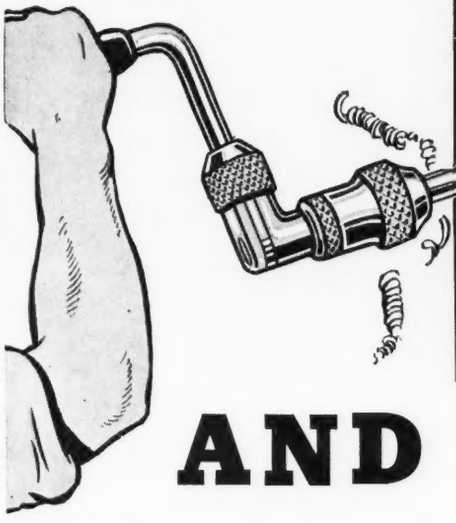
Self-contained diesel-driven, 210-cfm air compressor made with several types of portable and semi-portable mountings. Model 36-A, 4-cycle, 6-cyl, medium-high-speed diesel direct-connected to light-weight water-cooled compressor. Unit designed to permit easy inspection and servicing. Illustration shows unit with pneumatic-tired, 4-wheel portable mounting. Bulletin 3645-A1.

Fairbanks-Morse & Co, 900 S Wabash Ave, Chicago, Ill.



Of Course, No One Would Knowingly Damage Equipment

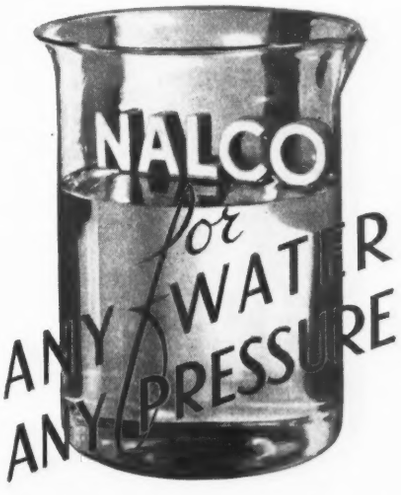




AND YET...

THE damage that can result from improperly conditioned boiler feedwater may momentarily seem inconsequential, but the accumulated effects are frequently unpleasant. Burned out tubes ... corroded plates ... scored valves ... eroded turbine vanes ... plugged condenser tubes and pipe lines can and do plague the plant that is inadequately protected. The minimum amount of such trouble in plants served by the Nalco System of Feedwater Treatment emphasizes the fact that protection is easy to obtain.

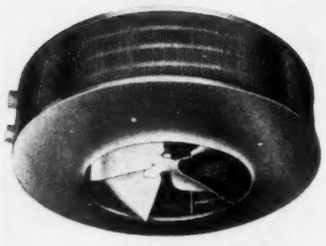
Adoption of the Nalco System requires no additional capital investment. Let us give you the entire story without obligating you in any way.



NATIONAL ALUMINATE CORPORATION

6222 W. 66th Place **Chicago, Illinois**

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, England. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay Street, Toronto, Ontario.



SPACE HEATER

CEILING-MOUNTED unit heater has 2-row circular coil mounted between two circular plates. Upper plate is supporting backbone of unit and carries motor. Lower plate provides orifice for fan. In operation, warm upper air is drawn through circular coil at low velocity and projected down to floor by 4-blade propeller fan with initial high velocity. Operates on either high- or low-pressure steam.

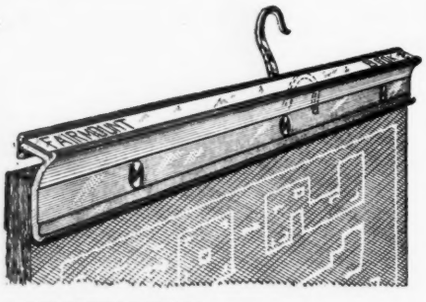
Trane Co, LaCrosse, Wis.

COMBINATION ELECTRIC HAMMER AND DRILL

IMPROVED combination electric hammer and drill has new type of tool retainer made of molded rubber, which fits over nose of hammer and holds cutting tool

in place with right amount of play for rapid drilling or cutting. Also keeps grit from getting into socket in overhead drilling.

Wodack Electric Tool Corp, 4627 W Huron St, Chicago, Ill.



BLUEPRINT BINDER AND HANGER

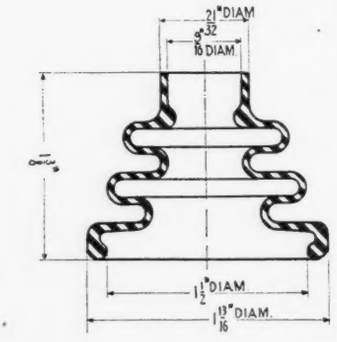
MADE of light duralumin with steel center hook that can be turned back for reference. Three telescoping binder screws with metal strip at back hold prints. Holes for permanent, or slots for temporary insertion may be cut with knife or shears. Renewable title strip may be lettered to suit. Stock sizes are 18, 24 and 30 in.

Wade Instrument Co, 2246 Brooklyn Station, Cleveland, Ohio.

SEALING GLAND

A GLAND, in use on a new Cummins diesel, seals connection between fuel pump and governor. On one side of boot, gland is subjected to fuel oil and other side to lubricating oil, temperature of which may vary from below zero to about 250 F. Boot permits longitudinal expansion and contraction, and at same time seals connection at each end. Seal is made of "Neoprene," which resembles rubber in elasticity, strength, resilience and abrasion resistance, but is said to resist better deterioration effects of oil, chemicals, heat, etc.

Rubber Chemicals Div, E I duPont de Nemours & Co, Wilmington, Del.



AIR VALVE

NON-LEAKING control valves for single- and double-acting cylinders, air or oil to 125-lb pressure. Made in ¼-, ⅜-, ½-, and ¾-in. sizes with flat bronze discs, protected seats, semi-steel bodies and seats. Full pipe area through ports may be

throttled or fully opened, as required. Valves can be disassembled without breaking connections. Total lever travel 90 deg, and levers may be adjusted radially to suit operator's convenience.

W H Nicholson & Co, 213 Oregon St, Wilkes-Barre, Pa.

STRAWS

Pointing the way business winds blow

ALABAMA — Electro Metallurgical Co has contracted to purchase from TVA a large block of industrial power which it proposes to use at a new plant to be erected in the Wilson Dam area. The proposed plant will manufacture ferro-alloys, calcium carbide, and other electric furnace products.

R H Carr Lumber Co, Jasper, plans new boiler plant in connection with rebuilding of planing mill and woodworking plant, recently destroyed by fire. Loss close to $75,000.

ARIZONA——Salt River Valley Water Users Assn, Phoenix, began construction first of October on a $500,000 diesel-electric plant. Contract for 5,000-kw diesel-generating unit was let to General Machinery Corp (Hooven, Owens, Rentschler) Hamilton, Ohio. Its cost installed is to be $420,000, and is to be in operation by May 1, 1938.

CALIFORNIA——San Diego plans 500,000-gal. elevated steel tank and tower for water supply system in La Mesa Heights district and 16-in. supply pipeline.

King City High School District, King City (Monterey County), plans central-heating plant in high-school auditorium building. $120,000 through Federal aid. Robert Stanton, Hotel Del Monte, Del Monte, architect.

Surprise Valley Electrification Corp, Belli Bldg, Alturas, contracted Fairbanks, Morse & Co, Chicago, for 900-hp diesel-generator unit and auxiliaries, at $75,600.

Kern County Union High School District, Bakersfield, plans central-heating plant in 2-story and basement junior high school at East Bakersfield. Cost about $420,000. Bids will be asked soon. Charles H Biggar, Haberfelde Bldg, Bakersfield, architect.

Sierra Mountain Water Co, Stockton, is considering hydroelectric plant on Cosumnes River. Application has been made to divert 300,000 acre-ft per annum for proposed station, for initial capacity of 13,840 hp. Cost over $1,500,000.

Board of Alameda County Supervisors, Oakland, will take bids soon for central-heating plant at Arroya Sanatorium, Livermore. Cost over $65,000. Will G Corlett, Bank of America Bldg, Oakland, architect.

COLORADO——Public Service Co of Colorado has awarded contracts for a combustion-control system on a new B & W pulverized-coal-fired boiler and a manual combustion-control system on existing boiler to Hagan Corp, Pittsburgh, Pa.

CONNECTICUT — School Board, Hartford, plans boiler plant in junior high school on Barbour St. $1,050,000 being arranged through bond issue.

E Ingraham Co, North Main St, Bristol, contracted Torrington Building Co, Torrington, for 1-story addition to boiler plant at clock factory. Additional equipment will be installed.

Danbury Hospital, Danbury, Arthur E Tweedy, president, plans central-heating plant for proposed 3-story addition in 1938. Cost about $300,000. William Sperry, Starrs Plain, Danbury, chairman of building committee.

FLORIDA — Jacksonville Beach plans municipal electric plant, with initial cost about $150,000.

Wayfair Dairies, Inc, West Palm Beach, plans boiler house at dairy-products plant on Military Trail, near city. Cost close to $70,000.

ILLINOIS — State Prison Department, State Capitol Bldg, Springfield, contracted Springfield Boiler Co, Springfield, for boiler, stoker, automatic combustion-control apparatus, instruments, feedwater-treating system and accessory equipment for power house at Illinois State Penitentiary, Joliet, at $50,633.00. Award for smoke breechings has been let to H P Reger & Co, Chicago.

Napierville plans 500,000-gal. elevated steel tank and tower for municipal water system, including feeder pipelines. Cost about $50,800. Wells Engrg Co, Geneva, consulting engineer.

Aurora contemplates diesel-generator units for waterworks pumping station and municipal street lighting. Harold M Achim, city engineer.

INDIANA——Washington has authorized extensions in municipal power plant, including equipment for combustion control, feedwater treatment, ash handling and other service. Bevington-Williams, Inc, Indiana Pythian Bldg, Indianapolis, consulting engineer.

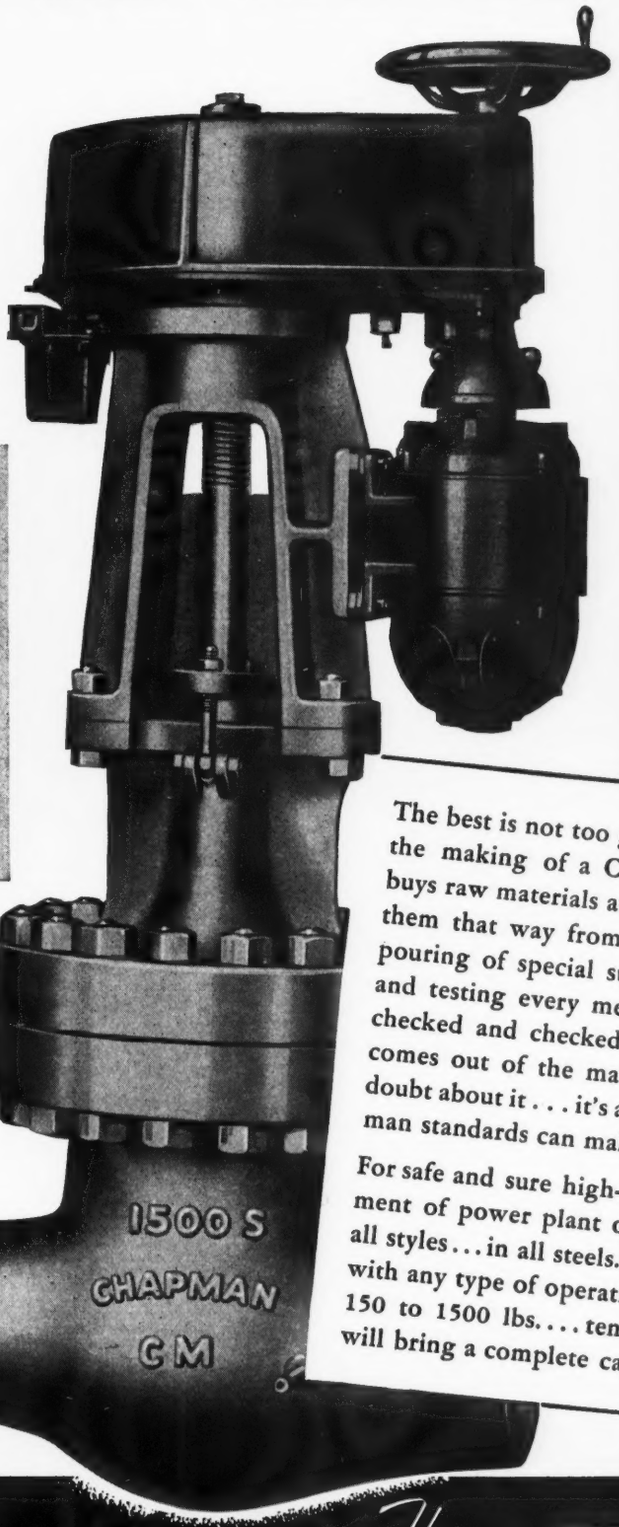
Indiana Boys' School, Plainfield, E M Dill, Supt, will add to power house at institution vertical, single-cyl, center-crank engine unit, forced-draft fan, soot blowers and auxiliary equipment. John M Rotz Engrg Co, Merchants' Bank Bldg, Indianapolis, consulting engineer.

Fort Wayne, contracted Bass Foundry & Machine Co, 1602 Hanna St, Fort Wayne, for high-pressure boiler unit and auxiliaries for municipal power plant, at $72,772. Also made award to Schwegmann-Witte Co, 127 West Jefferson St, Fort Wayne, for steam and oil piping at $10,950. C R McAnlis, City Hall, city engineer.

Greencastle Hospital, Greencastle, has authorized addition to central-heating plant and service building at institution. Cost about $47,000. McGuire & Shook, Fletcher Trust Bldg, architects, and John M Rotz Engrg Co, Merchants Bank Bldg, mechanical engineer, both Indianapolis.

IOWA——New Hampton plans extensions

CHAPMAN CONTROLS the making of these valves... every step of the way



High Pressure Steam Valve with Welding Ends, Equipped with Chapman Motor Unit.

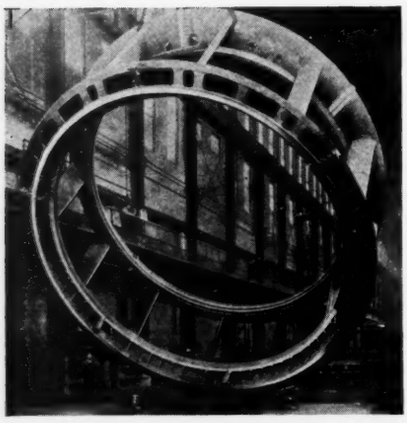
CHAPMAN STEEL VALVES ARE MADE IN THESE ALLOYS

Carbon Steel.
Carbon Molybdenum Steel.
Chrome Nickel Steel.
Nickel Steel.
Chrome Molybdenum Steel.
Chrome Tungsten Steel.
Chrome Nickel Tungsten Steel.

The best is not too good—when it's anything that goes into the making of a Chapman Power Plant Valve. Chapman buys raw materials as carefully as precious metals, and treats them that way from then on. Metallurgists stand over the pouring of special steels in Chapman's foundries, sampling and testing every melt. Then every casting, every part, is checked and checked again. And when the finished valve comes out of the machine shops, there's not the slightest doubt about it . . . it's accurate and able-bodied as only Chapman standards can make it.

For safe and sure high-temperature service in every department of power plant operation, Chapman makes valves in all styles . . . in all steels. Gate, globe, check and angle valves with any type of operating mechanism . . . for pressures from 150 to 1500 lbs. . . . temperatures to 1000° F. Return mail will bring a complete catalog to your desk. Write.

The **CHAPMAN VALVE**
MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS, U. S. A.



SPEED RING FOR PICKWICK LANDING

Shop view of assembled cast-steel speed ring for one of the two 55,000-hp hydraulic turbines under construction at Allis-Chalmers' Milwaukee plant for Pickwick Landing project of the TVA

In central municipal heating system, including pipelines, control equipment and accessories.

Emmetsburg plans municipal gas plant and distributing system. Cost close to $80,000.

Corning contracted Fairbanks, Morse & Co, Chicago, for diesel-generator unit and auxiliaries for municipal power plant, at $49,750.

Farmers' Creamery Co, West Bend, plans 1-story cold storage and refrigerating plant. Cost close to $30,000, with equipment.

Seymour plans extensions in municipal electric plant, including new engine-generator unit and auxiliary equipment. H S Nixon, Grain Exchange Bldg, Omaha, Neb., consulting engineer.

Central Electric Federated Co-operative Assn, Pocahontas, contracted Wickes Engrg & Const Co, 1441 Bluff St, Des Moines, for three diesel-generating units and accessories. Award for metal switch-gear has been made to Delta Star Electric Co, Chicago. Total cost about $260,000.

KANSAS——Atchison, Topeka & Santa Fe Railway Co, Topeka, plans addition to steam power house at shops at Dodge City. Cost close to $30,000.

Goodland contracted Fairbanks, Morse & Co, Chicago, for diesel-generating unit and auxiliary equipment for municipal power plant, at $94,710; also for electrical distributing system at $57,952, and for building unit, $24,542. An award for electric meters has been made to Sangamo Co, Springfield, Ill., at $10,137.50.

Washington contracted Fairbanks, Morse & Co, Chicago, for two diesel-generator units and auxiliary equipment for municipal power plant; also for electrical distribution system. Contract let to Sangamo Electric Co, Springfield, Ill., for electric meters. Plant will cost about $100,000.

KENTUCKY——Vanceburg plans municipal electric plant. $148,000 being arranged through bond issue to be voted at general election on Nov 2.

LOUISIANA——Pelican Cold Storage & Warehouse Co, Ltd., 1561 St. Louis St, New Orleans, La., has purchased group of four multi-story buildings at North Front and Clay Sts, and will remodel and equip for new terminal, with cold storage and refrigerating units. Cost about $85,000. Charles Behre, president.

Plaquemine has authorized diesel-generator set, deepwell turbine-pumping machinery, service pumping units and accessories for municipal waterworks. Cost over $60,000.

MAINE——Great Northern Paper Co plans $2,000,000 hydro plant at Mattaseunk, on the main branch of the Penobscot River. Proposed to generate a minimum of 18,000 hp, to be used at the company's mill at Millinocket.

(*Further Straws on page* 120)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Carbon Hill—Galloway Coal Co., Carbon Hill, plans coal handling, power plant and coal tipple. $250,000.

Colo., Alamosa—Public Service Co. of 15th and Champa Sts., Colorado, Denver, preliminary plans enlarging electric light and power plant incl. new generator, boiler and addition to power house to double plants present capacity. $300,000. G. Chipman, local mgr.

Ga., Brunswick—Hercules Power Co., c/o A. S. Kloss, local mgr., and Wilmington, Del., altering and constructing addition to plant and making improvements in dwellings, warehouse and other facilities, own forces. Est. **$150,000.** Private plans.

Ia., Esterville—Bids Nov. 1, by City, F. J. Ehlers, mayor, light plant improvement and extensions, incl. removal 250 B.H.P. Diesel engine unit; furnishing 1 new Diesel engine generating unit of not less than 1,500 B.H.P., with accessories all delivered upon City's foundation, incl. services of erector.

Ia., Primghar—Bids Nov. 2, by City, J. M. Metcalf, clk., constructing light plant and distribution system. $104,000. Buell & Winters, Insurance Exchange Bldg., Sioux City, engrs.

Kan., Hayes—Central Kansas Power Co., Abiline, plans steam electric power plant. $40,000.

Kan., Lawrence—Kansas Electric Power Co. plans power generating plant, $1,000,000. Sargent & Lundy, 140 South Dearborn St., Chicago, Ill., engr.

Kan., Topeka—University of Kansas Hospital, Topeka, plans by R. A. Coolidge, Topeka, power plant improvements, 39th and Rainbow Blvd., $75,000. Project and grant approved by P.W.A.

Kan., Topeka—Kansas Power & Light Co., 808 Kansas St., petitioned city for authority to place substations under sidewalks in downtown district and to place overhead wires underground. $750,000. W. E. Baldry, city engr., approved project.

Kan., Wichita—Kansas Gas & Electric Co., Wichita, plans electric power plant. $1,000,000.

Ky., Somerset—City is considering construction municipal light and power plant. To exceed $50,000.

Ky., Vanceburg—City election Nov. 2 to vote $148,000 bonds to finance construction of municipal light and power plant. City Engineering Dpt., engrs.

Ky., Williamstown — City, T. R. Well, mayor, plans light and power plant. $90,000. P.W.A. approved grant and project. City Eng. Dpt., engrs.

Minn., Springfield—Municipality plans addition to steam electric power plant. $140,000. Hitchcock & Estabrook, Sexton Bldg., Minneapolis, engrs.

Neb., Blair—City having survey made to determine advisability of increasing capacity of light plant, probably new generating unit. $30,000. Black & Veatch, 4706 Bway., Kansas City, Mo., consulting engr.

Neb., Fremont—City, plans new boiler unit and new light plant building. $225,000. Black & Veatch, 4706 Bway, Kansas City, Mo., consulting engrs.

Neb., Minatare—Municipality plans electric light and power plant and distribution system. $50,000. R. Fulton, Lincoln, engr.

N. J., Burlington—Public Service Electric & Gas Co. of New Jersey, 80 Park Pl., Newark, taking bids steam electric power plant. $800,000.

N. M., Artesia—Central Valley Electric Corp., c/o I. Resler, pres., plans constructing new power plant and 80 mi. distribution system. $255,000. **Maturity soon.** E. T. Archer & Co., New England Bldg., Kansas City, Mo., engrs.

N. Y., Buffalo—Niagara Hudson Power Co., Electric Bldg., soon takes bids from selected bidders for additional electric sub-stations. To exceed $40,000.

N. Y., Cobleskill—New York Power & Light Corp., 126 State St., Albany, plans constructing electric plant. $50,000. Hearings to be held before New York State Pub. Serv. Comn., Albany, at once.

N. Y., Oswego—Niagara Hudson Power Co., Electric Bldg., Buffalo, plans constructing steam power generating plant, including docks on Lake Erie. $10,000,000. Separate bids on turbines, etc.

N. Y., Rochester—Rochester Gas & Electric Co., 89 East Ave., plans enlarging electrical distribution system at Station 3, Platt St., incl. machinery and equipment, $124,824; additional rural electric lines in Monroe Co. and installing cable and switching equipment at Rochester Airport. $25,000 plus. Funds appropriated. **Maturity soon.**

O., Nelsonville—City plans improving municipal light and power plant. Election in November to vote $90,000 bonds for same.

O., Springfield—City has plans under consideration for construction of municipal power plant to be voted on in November. To exceed $50,000. W. E. Lucas, city engr.

O., Zanesville — Good Samaritan Hospital plans by J. M. Brielmaier, 735 North Water St., Milwaukee, Wis., 2 story, 107.6x137 ft., brick, steel laundry and boiler room, plain found.

Okla., Fort Cobb—City made sketches municipal light plant. $30,000. Engineer not appointed.

Okla., Marlow—City plans installing 700 hp. diesel engine and generator in city light plant. $50,000. Private plans.

Okla., Purcell—City plans installing 1,000 hp. diesel engine and generator in city light plant. $75,000. Private plans.

Okla., Stroud—City made preliminary plans installing 500 hp. diesel engine and generator in present city light plant. $30,000. Private plans.

Okla., Tulsa—City, D. Randall, clk., Blackwell, soon takes bids 4,000 kw. turbine and building for same. $300,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Okla., Waurika — City made preliminary plans municipal light plant. $75,000. Engineer not appointed.

R. I., Providence — Narragansett Electric Co., 49 Westminster St., Providence, brick, steel, concrete power sub-station, Eddy and Dyer Sts. Owner builds. To exceed **$40,000.** Private plans.

S. D., Freeman—City voted $100,000 bonds for municipal light plant. Buell-Winters Eng. Co., Sioux City, Ia., engrs.

Tenn., Clarksville—Municipality plans electric light and power plant. $250,000.

Texas—Brazos River Conservation & Reclamation Dist. of the Lower Colorado River Authority, c/o J. A. Norris, genl. mgr., c/o Kyle Hotel, Temple, have authorized Ambursen Eng. Corp., engrs., 295 Madison Ave., New York, to complete plans for construction of 13 or 14 dams on the Colorado River, this in addition to Possum Kingdom Dam and assurance full engineering powers for consummation of entire project for flood control, irrigation and hydro-electric power. About $23,000,000. Total $30,000,000.

Tex., Huntsville — City, c/o J. M. Smith, mayor, plans 1 story, 34x70 ft., steel frame and structural steel, hollow tile light and power plant, and street lighting system, incl. three 300 hp. Diesel engines, etc., concrete pile found. $150,000. Garrett Eng. Co., 300 Hughes St., Houston, and c/o mayor, engrs. P.W.A. allotted $150,909 for above, but city has just requested P.W.A. to rescind allotment.

Utah, Manti — Municipality plans electric power plant improvements. $50,000.

Wash., Anacortes — Puget Sound Pulp & Timber Co., having surveys made for construction steam plant. $300,000. H. P. McCurdy, 2929 16th Ave. S.W., Seattle, engr.

W. Va., Lumberport — Harrison County Rural Electric Assn., E. V. Richardson, in charge, plans steam electric power plant. $100,000. L. T. Klauder, Lincoln Liberty Bldg., Phila., Pa., engr.

Wis., Milwaukee—J. P. Pullman, pres. Wisconsin Public Service Corp., announced that application for approval to construct $1,500,000 hydro-electric plant will be filed with Wisconsin Public Service Comn. in near future. The increased sale of electricity in the territory served by the corporation necessitates additional sources of power. Tentative plans are now being drawn for the proposed station and construction is expected to be started during 1938. The proposed plant will have capacity approximately 17,500 kilowatts and will be located in the Wisconsin River valley where the greatest demands are being made for additional power. The plant will be situated on the Wisconsin River midway between Merrill and Tomahawk below the corporation's present Grandfather Falls plant.

Wyo., Afton—Lower Valley Power & Light Co., Inc., Afton, soon takes bids electric power plant and distribution. To exceed $40,000.

B. C., Dawson Creek—Dominion Electric Power Co., Ltd., preparing plans new plant. $75,000.

Ont., Sault Ste. Marie—Great Lakes Power Co., Ltd., Sault Ste. Marie, soon lets contract electric power plant. $1,000,000.

Palestine-Tel-Aviv—Palestine Electric Corporation, Ltd., 2 Grosvenor Gardens S.W., London, plans new generating station. $1,000,000.

Germany, Berlin — The Rhine, Main and Danube Rivers Co., plans constructing 7 new power stations on River Main and for making navigable for deep draft ships the Danube, Main and Rhine Rivers. $6,000,000.

Read how Shell kept this company's wheels turning... Averted large financial loss!

LOADS OF 25 TONS—temperatures as high as 300° F.—that means a tough lubricating job in any man's language! And that was the problem faced by Shell at the Technical Porcelain Company plant at El Cerito, Cal.

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A thorough survey of all operating conditions was made. Then the Shell Bearing Lubricant perfected by Shell to meet tough operating conditions of just this kind was recommended and applied. The result of the application of that Shell Industrial Lubricant was *more* than just the elimination of frozen bearings! Today it is necessary to lubricate the bearings only twice a week—a real labor saving. Consumption of lubricants has been cut in half—another dollar-and-cents saving!

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SHELL *INDUSTRIAL* LUBRICANTS

It Depends on Who's Telling the Story . . .

AUNT LIZ PROCTOR took on a couple of hired hands just before last harvest. Charlie was a God-fearing churchgoer and brought a handful of recommendations, but Sam was shiftless and just got hired because nobody else came around.

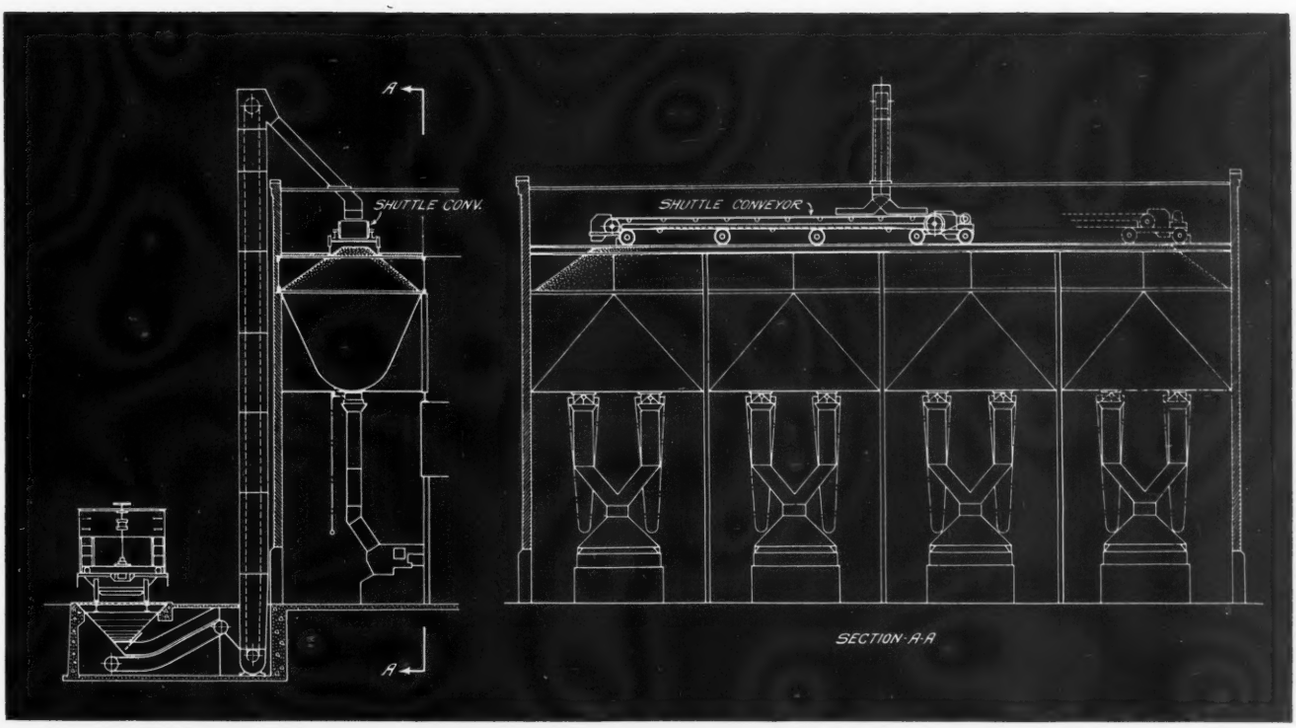
Charlie sort of rubbed in the difference in their positions by ignoring Sam as much as possible. That itched Sam no end, but there wasn't much he could do about it 'cept chew his cud. Then along came a tornado, and Charlie, hurrying across the barnyard with a bucket of milk, was swept away. Shiftless Sam sort of hitched up his overalls and hunted up Aunt Liz. "Mizz Proctor," he began, "You know that Charlie you hired that had the fancy recommendations?" "Yes," said she, "What about him?" "Well," says Sam, "He just beat it with yer bucket of milk!"

All of which goes to prove that it isn't so much what a man is as what he's painted. The best engineer in the world, if he can't convince somebody else of the fact, might just as well be the worst. More men have been damned by a careless, "He's a swell fellow, BUT—" than by any mistakes they may have made themselves.

We all must be careful what we say and how we say it, particularly when somebody else is involved. A casual slighting word to an associate or a mutual superior can do harm that years of explaining can't entirely remedy. Any story depends a lot on who is telling it. Above all, make your story straight and clear to the listener.

George Edwards

GEORGE EDWARDS
Engineer



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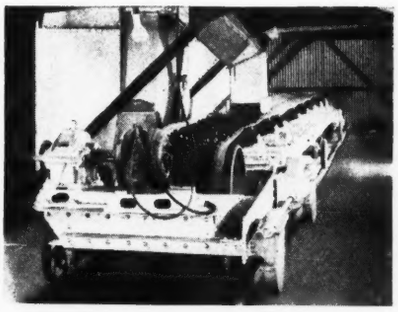
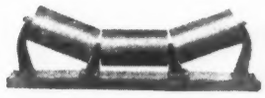
The steady, quiet travel of the shuttle frame and the travel of the reversible Conveyor Belt mounted on this frame, automatically distribute the coal evenly throughout the entire length of your bunker. Economical? Yes. The Belt Conveyor costs less because it is shorter than a tripper line, only one motor is used and no tripper is required. The compact design permits its use in confined spaces such as between members of a roof truss or under a low roof. With the Robins Shuttle Conveyor you can enlarge your bunker capacity by bringing it nearer the roof. Lower power consumption and little or no maintenance cost makes this system a most economical and dependable method of filling your bunker.



The belt runs in one direction for filling half the length of the bunker and in the other direction to fill the second half.

Robins Shuttle Conveyor is described on page 73 of bulletin 82 A. Other products have special pages and bulletins. Send for sheets of interest.



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Goetze for GASKETS

STRAWS (Continued)

MASSACHUSETTS——General Fibre Box Co, Circuit Ave., West Springfield, plans 1-story steam power house at plant. Cost close to $30,000. McClintock & Craig, 458 Briggs St, Springfield, consulting engineers.

Dehydrating Process Co, 6 Mount Washington Ave., South Boston, plans addition to boiler plant at factory. Cost close to $25,000. Thomas McSweeney, 77 Summer St, Boston, consulting engineer.

MICHIGAN——State Refining Co, Grand Rapids, Ernest Wellman, president, plans boiler plant and pumping station at new 1500-bbl oil refinery. Cost over $100,000.

MINNESOTA——Board of Education, Lakefield, plans steam power house at local school for central heating. Bond issue of $20,000 authorized.

Adrian contracted Worthington Pump & Machinery Corp, Harrison, N. J., for diesel-generator unit and accessories for municipal power station, at $27,942.

Westbrook plans municipal power plant. Cost about $70,000. Bond issue being arranged.

Lake Crystal contracted Fairbanks, Morse & Co, Chicago, for diesel-generator unit and auxiliaries for municipal power plant. Board of Dakota County Commissioners, Hastings, plans automatic coal stokers in power station for Court House.

MISSISSIPPI——Baptist Orphanage, Woodrow Wilson and North Bailey Aves., Jackson, W N Taylor, in charge, plans steam power house at institution. $125,000 being arranged. J M Spain, New Merchants' Bank Bldg, Jackson, architect.

MISSOURI——Shell Pipe Line Corp, Shell Bldg. St. Louis, plans welded-steel pipeline from Roxana, Ill., to Indianapolis, Ind., about 260 miles, for crude-oil transmission. Cost close to $3,000,000.

NEBRASKA——Blair plans improvements in municipal power station. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Fremont plans extensions in municipal power plant, including installation of generator unit and accessories, high-pressure boiler and auxiliary equipment. Cost about $225,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Alliance plans addition to municipal power plant, including 2000-kw turbine-generator and accessories, surface condenser, boilers and complete auxiliary equipment. Cost about $240,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

NEW HAMPSHIRE——Gordon Woolen Mills, Hillsborough, has installed a new power plant during extensive remodelling operations

NORTH CAROLINA——Glanton Veneer Co, Whiteville, is considering boiler house in connection with rebuilding of veneer mill, recently destroyed by fire.

NEW YORK——Keystone Pipe Line Co, Philadelphia, Pa., plans welded-steel pipeline from terminal to be built at Tonawanda, to Utica, about 220 miles. To include booster service. Cost over $1,000,000.

Delco Appliance Corp, 391 Lyell Ave., Rochester, plans steam power house at local plant on Mount Read Blvd. Cost close to $60,000.

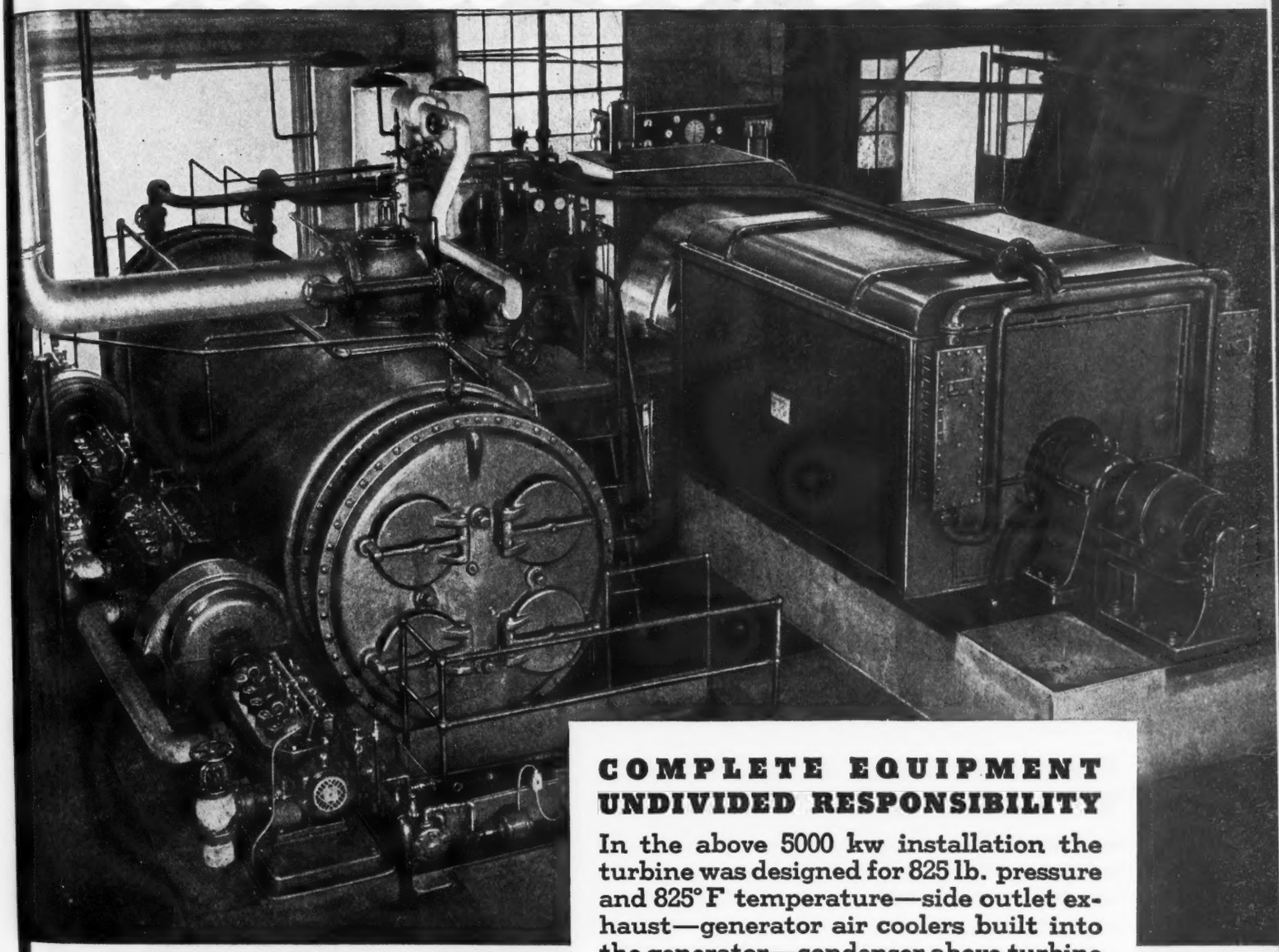
OHIO——Columbus Grove plans improvements in municipal power plant, including diesel-generator unit and auxiliaries. Cost about $66,000.

Crystal Tissue Co, Middletown, contracted General Electric Co for 2000-kw turbine-generator unit, and Elliott Co for bleed-type condenser. Orders for other equipment will be placed in near future, including coal- and ash-handling equipment, switchboard, and instruments. W I Barrows, Reibold Bldg, Dayton, consulting engineer.

Otis Steel Co, Cleveland, has awarded a contract to Hagan Corp for a complete combustion-control system with furnace pressure, gas pressure and air-gas ratio control to be installed on a regenerative soaking pit.

(*Continued on page* 122)

ENGINEERED



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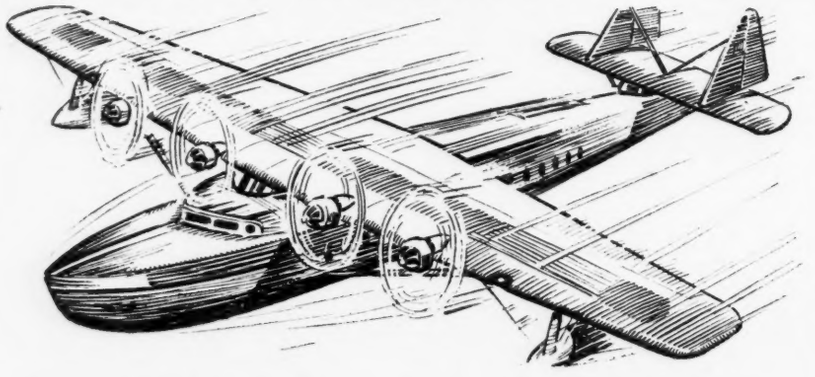

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STRAWS (Continued)

State Dept of Public Welfare, Columbus, contracted Skinner Engine Co. Erie, Pa., for engine unit, and Crocker-Wheeler Co, Ampere, N. J., for generator and accessories, for power house at State Hospital at Toledo. Also, contracted E Keeler Co, Williamsport, Pa., for boiler unit, and Westinghouse Elec & Mfg Co., East Pittsburgh, Pa., for stoker, for State Hospital at Dayton.

Ohio Crankshaft Co, 6600 Clement Ave., Cleveland, has approved plans for 1-story boiler plant at factory. Cost close to $40,000. Wilbur Watson & Associates, 4516 Prospect St, consulting engineers.

Clark Grave Vault Co, 375 East Fifth Ave., Columbus, plans 1-story boiler house at factory. Cost about $25,000 with equipment. Raymond Cornelius, 232 High St, engineer.

Reynolds Spring Co has awarded a contract to Power Piping Corp, Pittsburgh, Pa., to design, engineer and construct all steam and high-pressure hydraulic piping, including boiler plant and heating system, for a new molded-plastics plant to be erected in Cambridge. Reynolds headquarters are in Jackson, Mich.

Newcomerstown Produce Co, Newcomerstown, R H Brumbach, general manager, plans cold storage and refrigerating plant. Cost close to $40,000.

Joslin-Schmidt Corp, Smalley Rd, Lockland, Cincinnati, plans extensions in power house at packing-house byproducts plant, with installation of new boiler unit, stoker and auxiliary equipment. Cost close to $40,000.

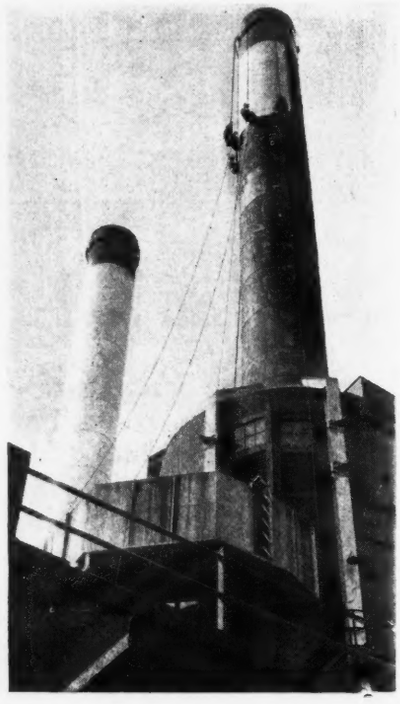
PENNSYLVANIA——Reading is arranging for bond issue of $4,700,000, to be voted at general election, Nov. 2, for municipal electric plant and distribution system.

SOUTH CAROLINA——Lowman Home for Aged and Helpless, White Rock, plans steam power house at institution for central-heating service. Robert L Clemmer, Hickory, in charge.

School Board, Charleston, plans central-heating plant in new 3-story junior high school on Race St. Cost $280,000. David B Myer, Peoples Bldg, Charleston.

SOUTH DAKOTA——Freeman plans municipal electric plant and distributing system. $100,000 has been authorized.

(*Continued on page* 124)



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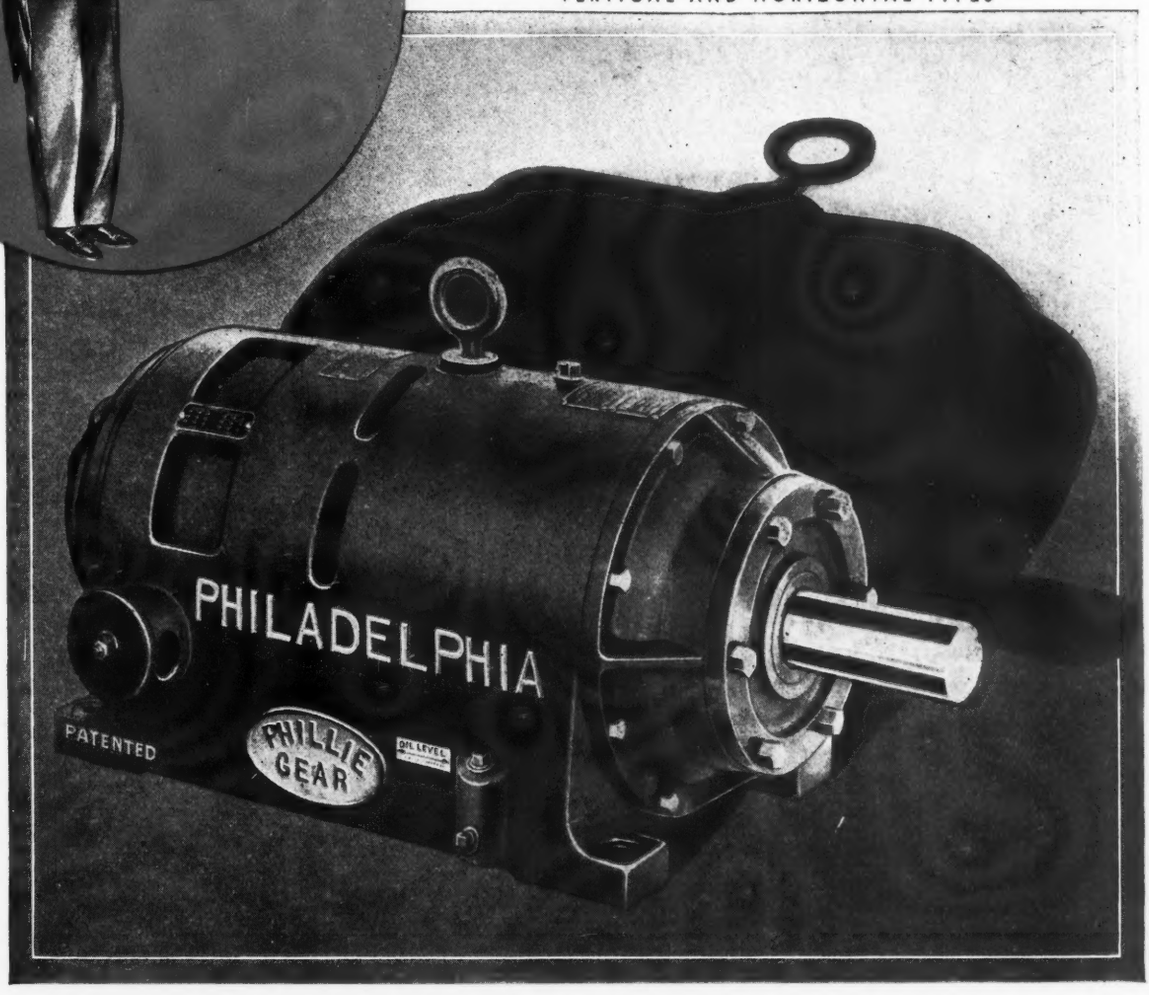

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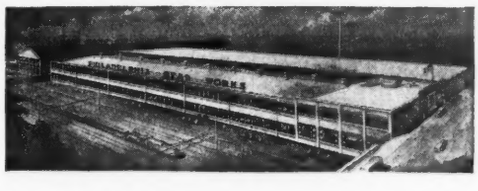

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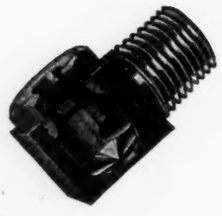

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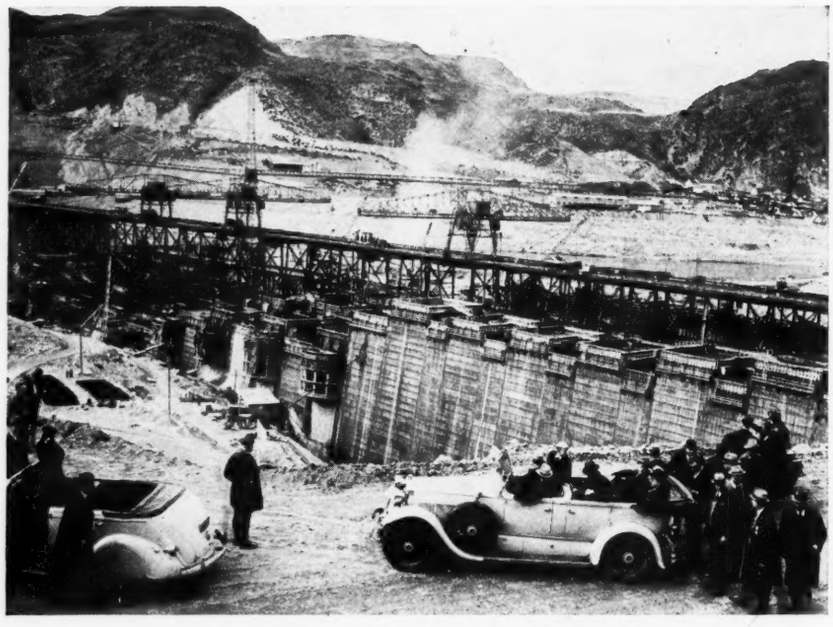

F D R TAKES A LOOK AT GRAND COULEE

President Roosevelt views Grand Coulee Dam on his recent trip through the Northwest. At the dam will be two power houses, each to have nine 140,000-hp units, aggregating 2,500,000 hp. The dam, when completed will be 4,100 ft long, 540 ft high, contain 10,000,000 cu ft of concrete, and will form a reservoir of 9,610,000 acre-ft.—*Wide World Photo*

STRAWS (Continued)

TEXAS——Pontiac Refining Corp, Nixon Bldg, Corpus Christi, plans steam power house and pumping station at new oil refinery. Cost about $100,000. Mid-Continent Engrg Co, First National Bank Bldg, Dallas, in charge.

Columbian Carbon Co, 41 E 42nd St., New York, N. Y., plans large compressor station and power house at new carbon-black plant near Corpus Christi, with steel pipeline to gasoline refinery of Southern Mineral Corp, in vicinity, for residue-gas transmission from that plant. Cost about $400,000.

Kadane-Brown Creamery Co, 910 South Harwood St, Dallas, plans 1-story ice and refrigerating plant. H E Brown, secretary, in charge.

City Council, Fort Worth, and Board of Tarrant County Commissioners, Fort Worth, plan steam power house for central-heating service in new city-county hospital and nurses' home. Cost $500,000.

State Board of Control, State Capitol Bldg, Austin, plans power house and utilities building at new West Texas State Hospital, Big Spring, to cost about $100,000, with equipment. Wyatt C Hedrick, First National Bank Bldg, Fort Worth, architect.

Sevier Hotel, Corpus Christi, plans central-heating plant in new multi-story hotel on Broadway. A cold storage and refrigerating plant, and air-conditioning system will be installed. Cost about $1,500,000. Frank T Drought, First National Bank Bldg, San Antonio, mechanical engineer.

Valley Pipe Line Co, McAllen, will build 5½-in. welded-steel pipeline from oil field area at Samfordyce to Port Isabel, about 16 miles, for crude-oil transmission. Cost close to $100,000.

Board of Port Commissioners, Brownsville, contracted General American Precooling Corp, 135 South LaSalle St, Chicago, for installation of precooling plant and system in building on waterfront.

Dr. Clay Nichols, Luling, heads corporation to construct 2-story hospital at 16th and San Antonio Sts. Austin, to include boiler plant and air-conditioning system throughout hospital building. Cost about $200,000.

Humble Oil & Refining Co, Houston, has authorized welded-steel pipeline from oil field area at Means, Andrews County, total distance of 50 miles, for crude-oil transmission. Cost about $400,000.

VIRGINIA——E I du Pont de Nemours & Co, Inc., Rayon Div, will carry out extensive additions to power plant at mill at Waynesboro. Cost over $150,000.

Danville contracted Ligon & Ligon, 3310 Ridgewood Ave., Baltimore, Md., and Sammons-Robertson Co., 414 11th St, Huntington, W. Va., for construction of Big Bend section of municipal hydroelectric plant at Pinnacles of Dan River, on joint bid of $571,600.

WASHINGTON——Puget Sound Pulp & Timber Co, Bellingham, plans extensions in power house and sulphite pulp mill. $2,500,000 being arranged for entire project.

Gilt Top Brewery, 901 Broadway, Spokane, plans 1-story steam power house, 35x50 ft at brewing plant. Cost close to $40,000. Henry C Bertelsen, Arthur D Jones Bldg, architect.

Board of Trustees, University of Washington, Seattle, plans addition to boiler plant at institution. 50x70 ft and 65 ft high. Bids to be asked in October. Lincoln Bouillon, 1411 4th Avenue Bldg, consulting engineer.

State Hospital Department, Olympia, has authorized installation of new turbine-generator and auxiliary equipment in power house at Northern State Hospital, Sedro-Woolley.

WEST VIRGINIA——Godfrey L Cabot, Inc, Union Bldg, Charleston, operating carbon black and natural gas properties, will build welded-steel pipeline from point near Sissonville, to Grantsville.

United Gas Fuel Co, 1023 Quarrier St, Charleston, contracted Williams Brothers, Inc, National Bank of Tulsa Bldg, Tulsa, Okla., for 18 and 20-in. welded-steel pipeline from point near Cedarville to Marjorsville, about 96 miles. Also contracted National Tube Co, Pittsburgh, Pa., for pipe. Cost about $2,000,000.

WISCONSIN——Wisconsin Power & Light Co, Fond du Lac, plans addition to local artificial-gas plant on West Johnson St, and installation of equipment.

George A. Whiting Paper Co, River St, Menasha, contracted Fluor Brothers Const Co, 48 Otter St, Oshkosh, for 1-story boiler house, 26x48 ft., at paper mill. Cost over $40,000. Orbison & Orbison, 215 E Washington St, Appleton, consulting engineers.

Wisconsin Power Cooperative Assn, Chippewa Falls, Walter M. Leonard, secretary, contracted Busch-Sulzer Brothers Diesel Engine Co, St. Louis, for three 1000-hp diesel generator units, with exciters and complete accessories, at $86,003.